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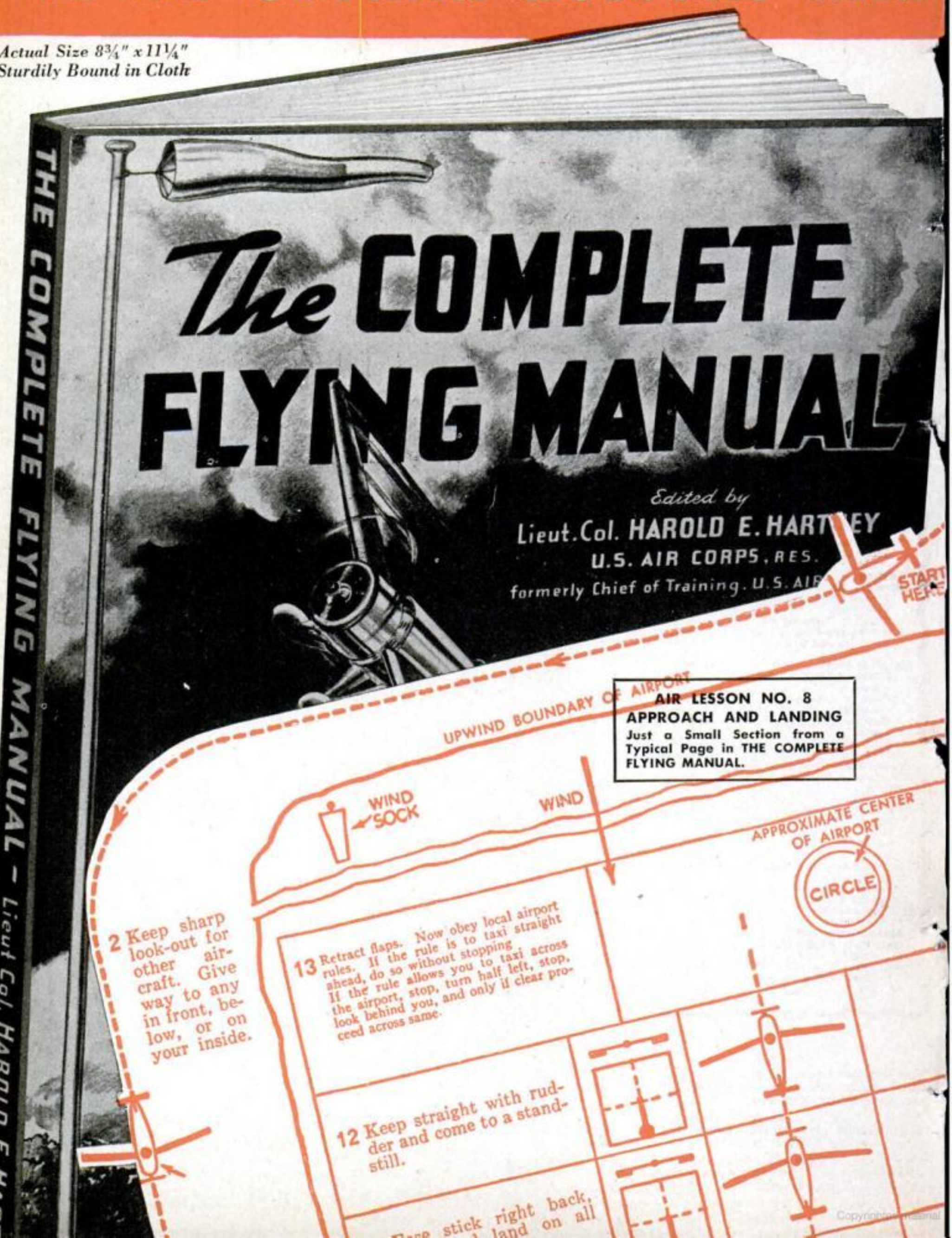


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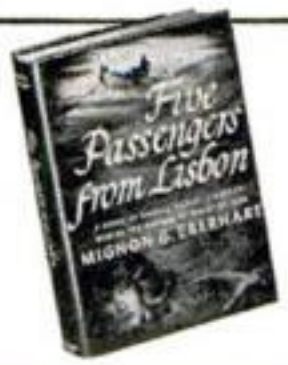
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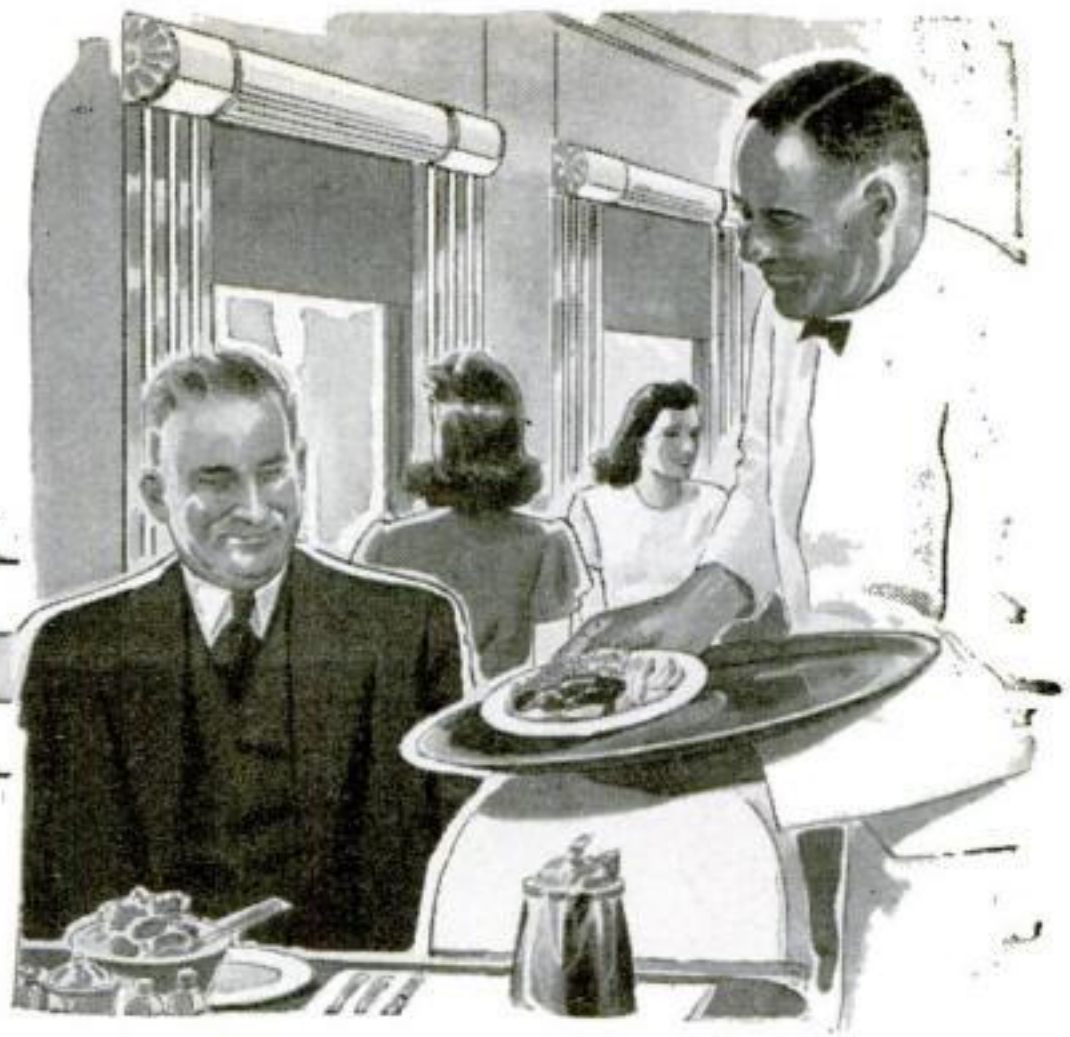
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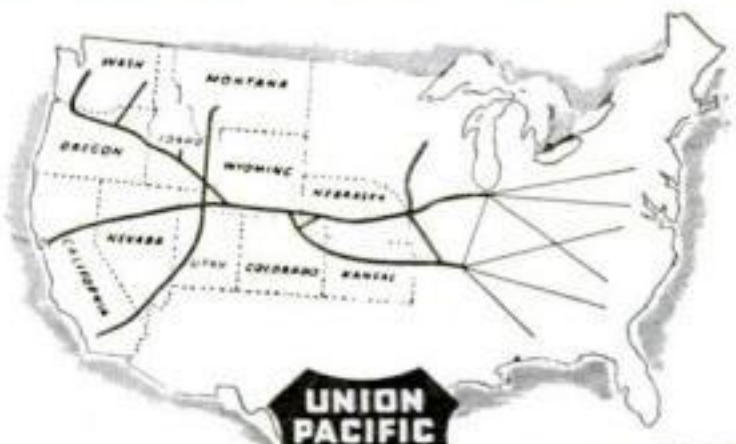
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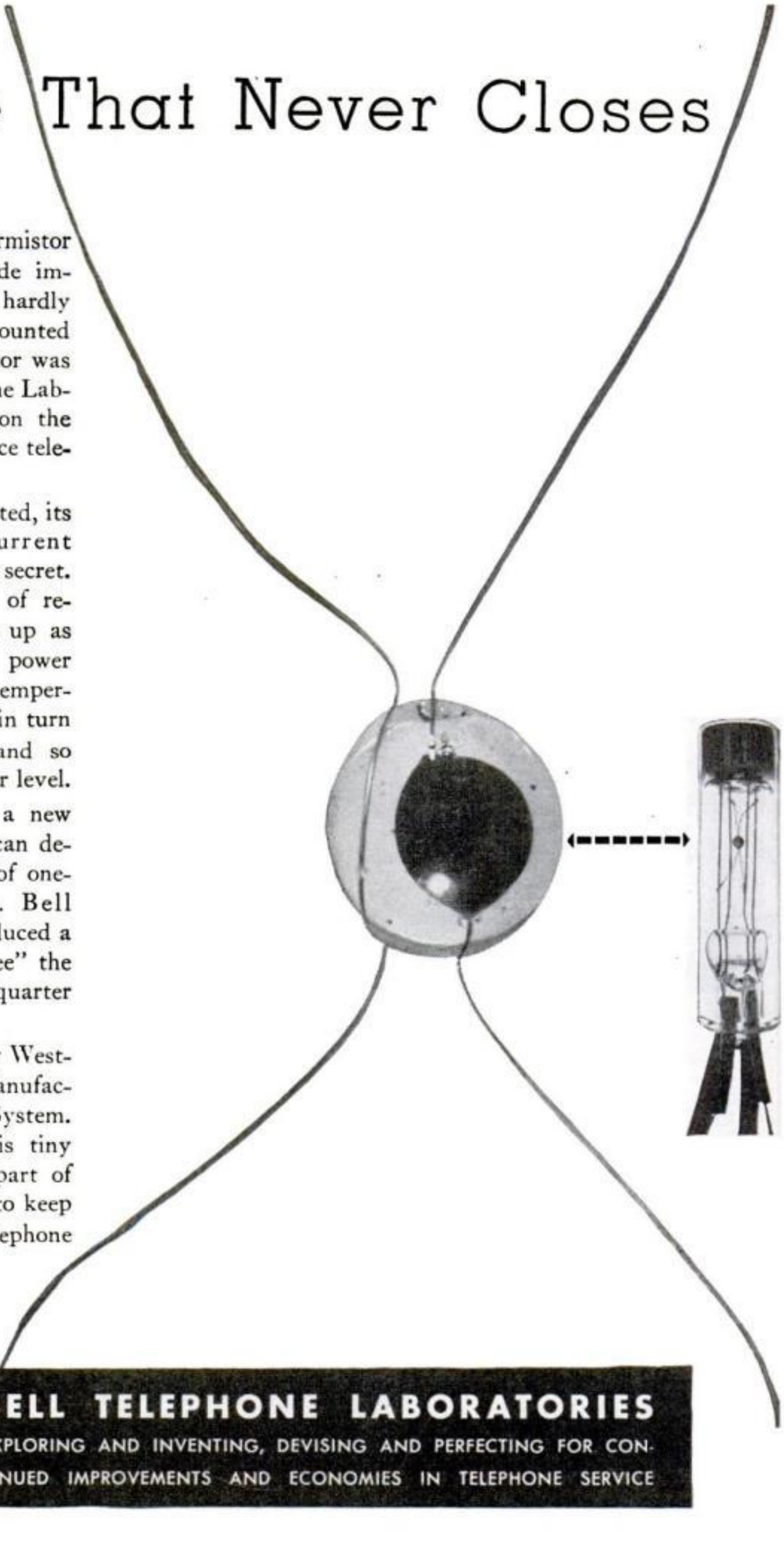
The Eye That Never Closes

You are looking at a thermistor —a speck of metallic oxide imbedded in a glass bead hardly larger than a pinhead and mounted in a vacuum. The thermistor was developed by Bell Telephone Laboratories to keep an eye on the amplification in long-distance telephone circuits.

When a thermistor is heated, its resistance to electric current changes rapidly. That is its secret. Connected in the output of repeater amplifiers, it heats up as power increases, cools as power decreases. This change in temperature alters the resistance, in turn alters the amplification, and so maintains the desired power level.

Wartime need brought a new use for this device which can detect temperature changes of one-millionth of a degree. Bell Laboratories scientists produced a thermistor which could "see" the warmth of a man's body a quarter of a mile away.

Thermistors are made by Western Electric Company, manufacturing branch of the Bell System. Fundamental work on this tiny device still continues as part of the Laboratories program to keep giving America the finest telephone service in the world.



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POPULAR SCIENCE MONTHLY

VOICE OF SCIENCE



Dear Bill: it's WORSE!

Bill is a very real guy. He knows his business, and he has a razor eye for a tenth of a percent. His business involves, more than most, the sharp statistics of people and sales.

At lunch, the other day, with Volta Torrey and myself, Bill posed a question. He had read the papers, seen the newsreels, and had just finished John Hersey's "Hiroshima" in *The New Yorker*—which was the first factually emotional account of what it was like on the wrong end of an A-bomb.

Bill asked, "Is it really as bad as they say?"

Torrey, who was at Bikini, said it was worse.

Bill listened with interest. He knew about radioactivity and blast effect. But he still harbored, I am afraid, a hope in the shape of a statistical doubt. Having burned his finger with a match, he could understand a forest fire. But there was nothing in Bill's—or anyone's—experience on which to base an understanding of that fire without flame called radiation. There was no memory of natural destruction big enough to grasp the actuality of atomic devastation.

Here, Bill, is a partial picture of that total devastation. It is only a piece of the picture, because it shows only a few blocks out of hundreds shattered; because it does not show the people or what happened to them. This picture, printed here for the first time, was taken by Bob Smith, PSM photographer then in the Marines, from a Piper Cub flying under 500 feet. It is a picture of Nagasaki *three months* after the bomb.

Perry Githens



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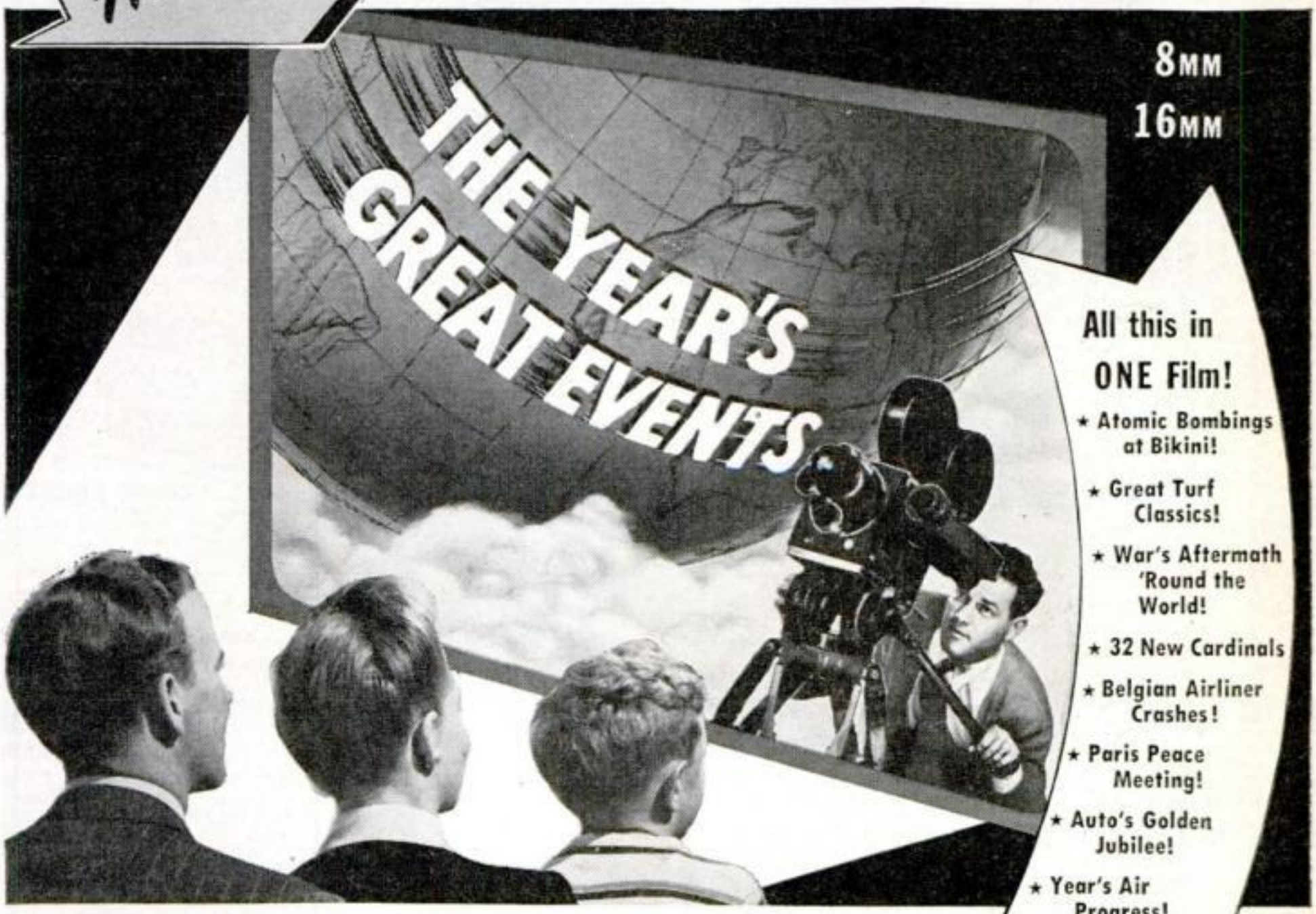
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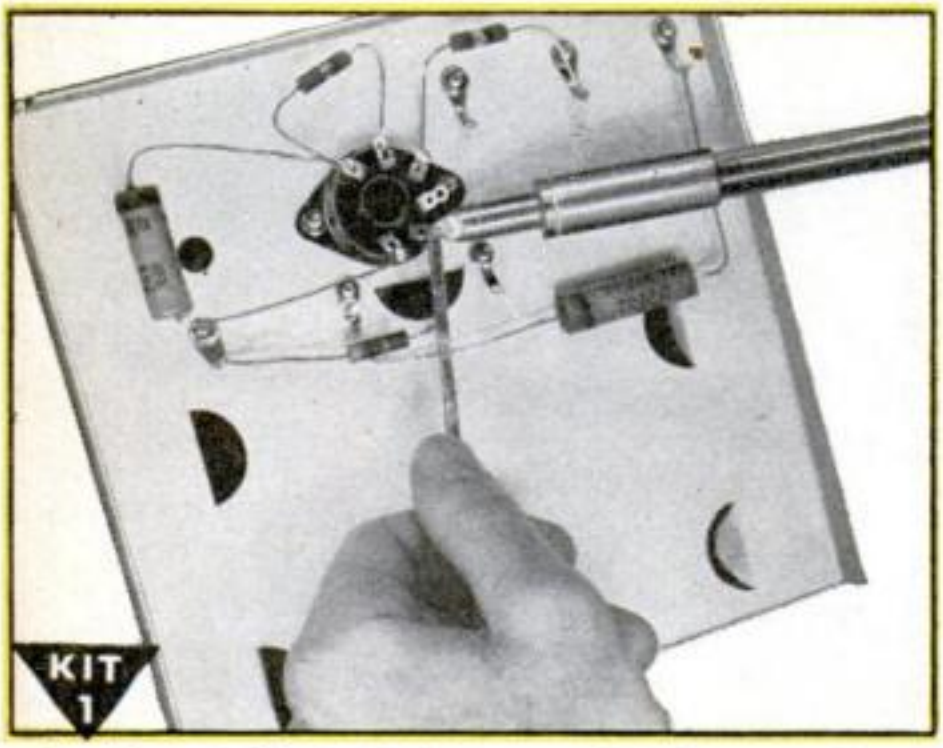
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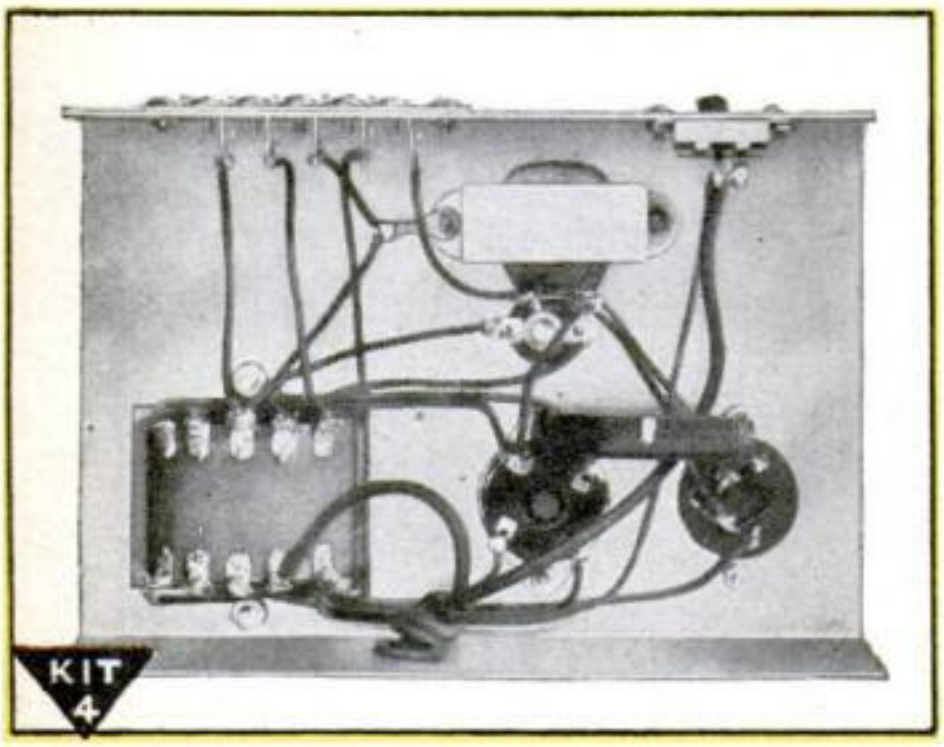
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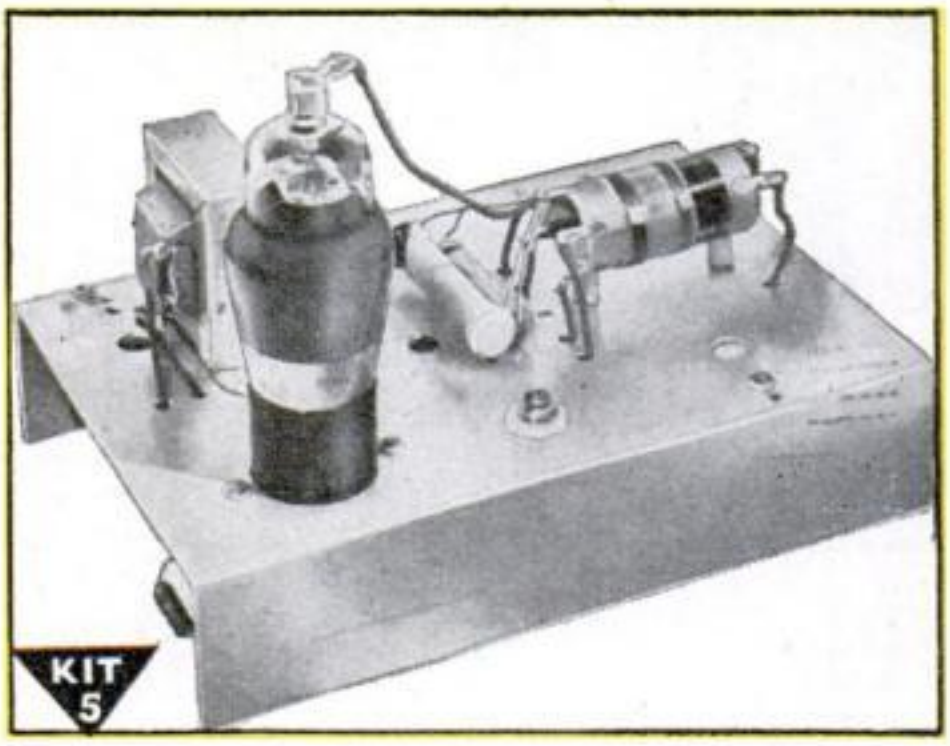
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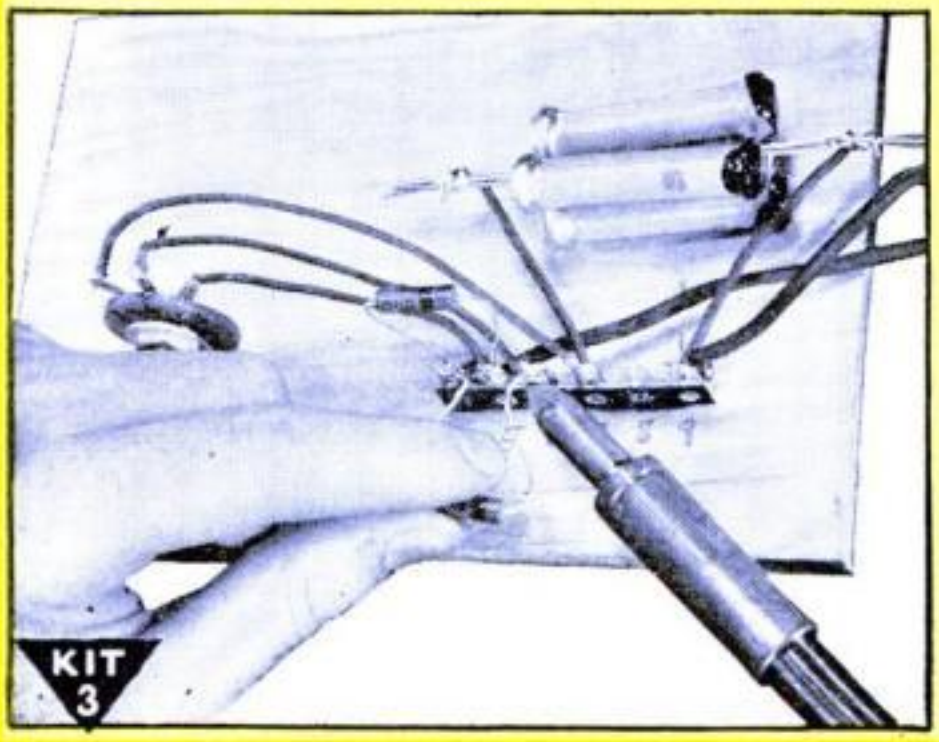
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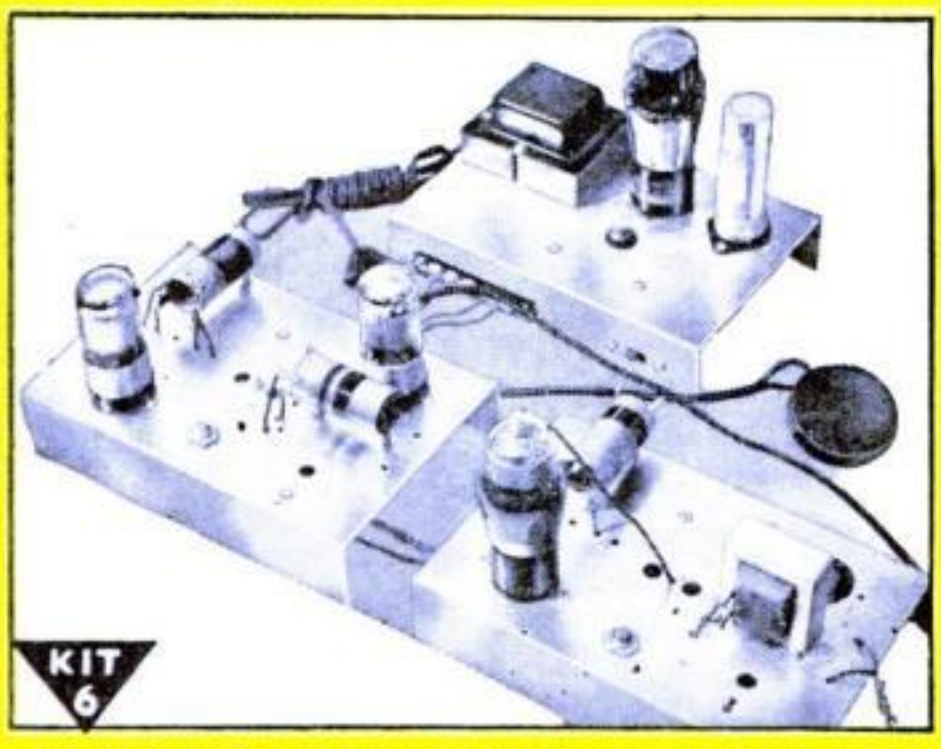
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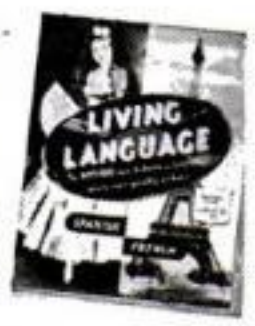
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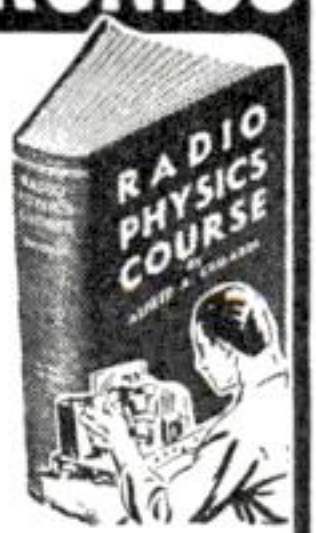
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After 25 years teaching . . . I am thankful that some of my students are among those who are now contributing to the advance of human knowledge. . . . Today the sciences are in too many cases taught by persons who majored in something else. That will not make for good science teaching or a flow of future scientists in America.

R. E. BOWMAN

Blacksburg, Va.

The Pace of Progress

Sir:

I am a regular reader of Popular Science, and find the spate of ideas bewildering and confusing. It is almost painful to see that America is progressing at this amazing rate while we in the East are so backward. . . . How I wish America would come and help us develop this country. Your citizens enjoy numerous benefits of civilization, while we fellow citizens of the world . . . are still very far behind.

V. CHORLEY

Veyangonda, Ceylon

Oil-Burner Advice

Sir:

. . . "How to Service-Check Your Oil Burner," by Harold P. Strand, was a good article, but Mr. Strand made a recommendation for servicing thermostats that we believe will cause some trouble. He suggested cleaning

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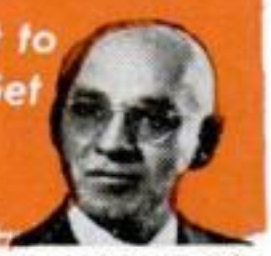
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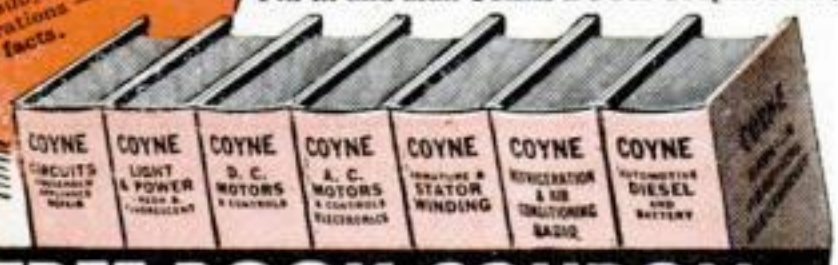
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Correction

Sir:

In that story by Devon Francis on new locomotives, in your October issue, one caption says "The parts of a locomotive tell many things about it." Then it goes on to say that the photo shows an old-style piston-valve engine. It pains me to have to tell you that, in this case, the parts didn't tell you right. The engine shown is a poppet hog (locomotive to you).

CASS REAGAN
New York City

PSM sadly admits the error. In self-defense, it also admits that Reader Reagan's eyes are sharper than those of the experts of two locomotive companies and one research organization—who checked the pictures and found no fault.

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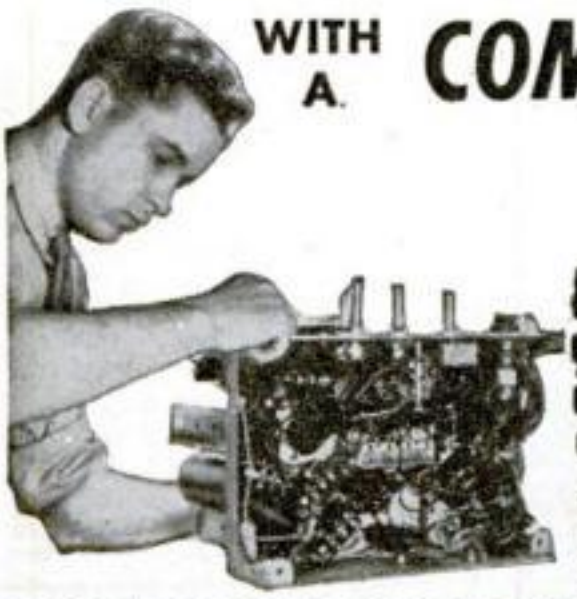
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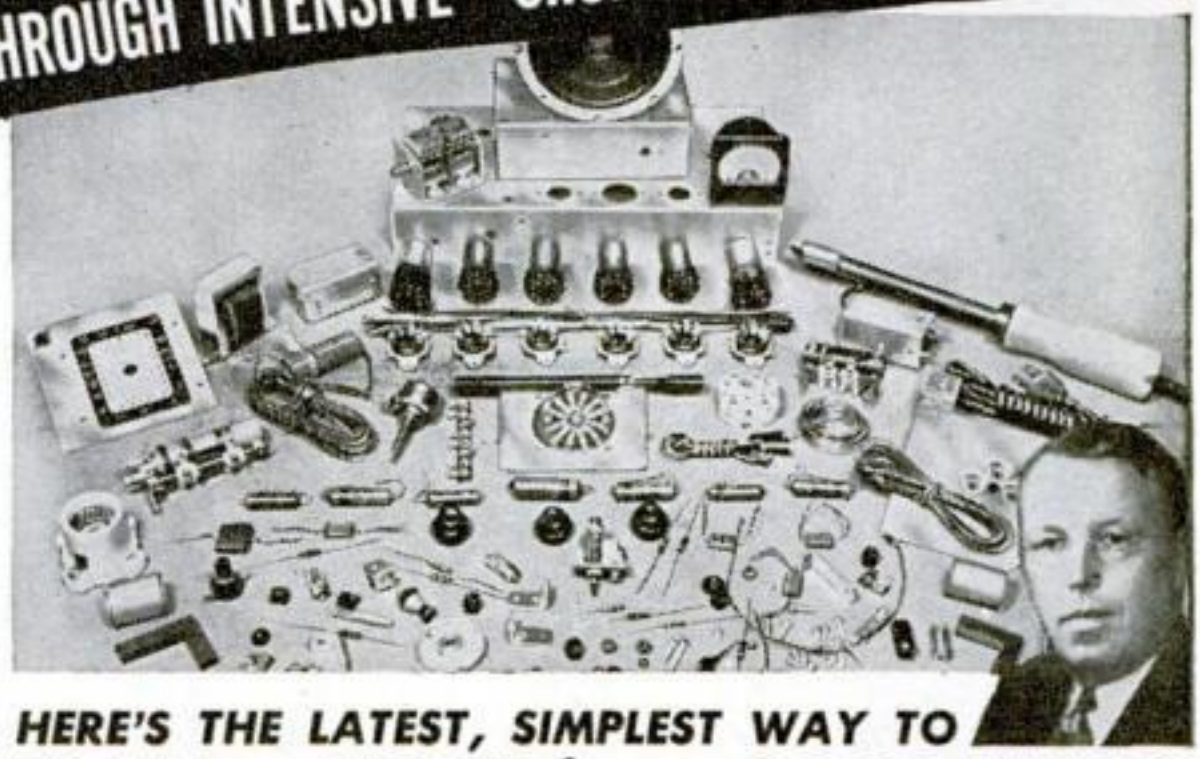
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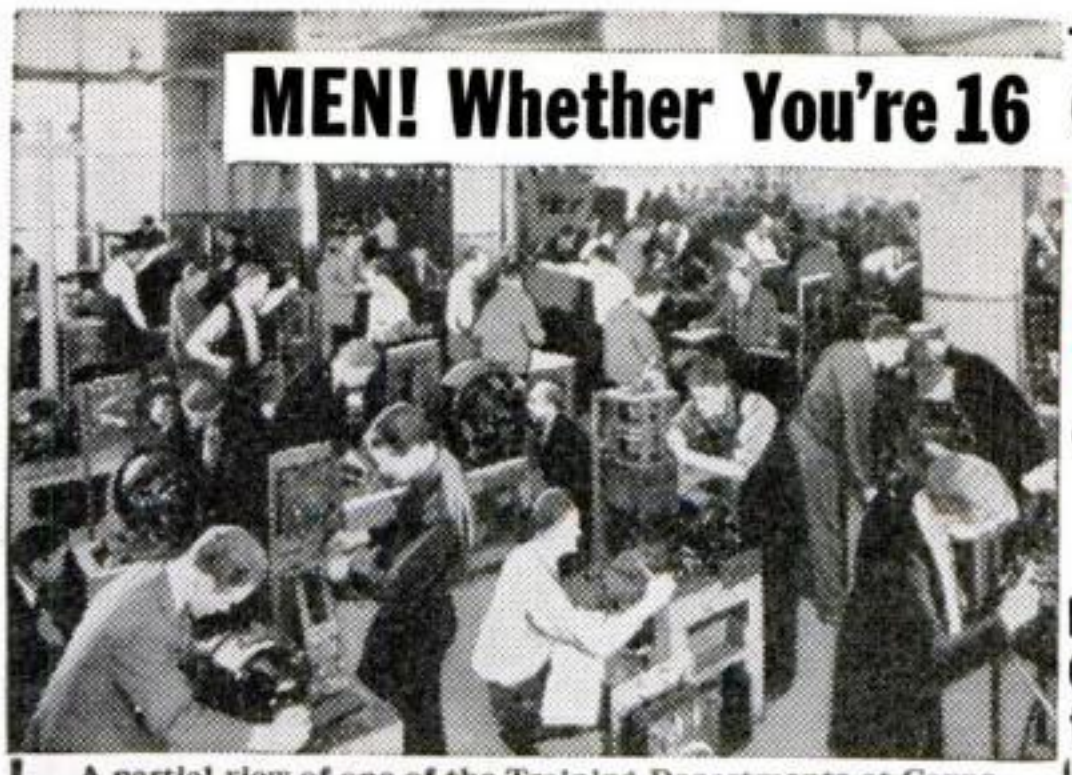
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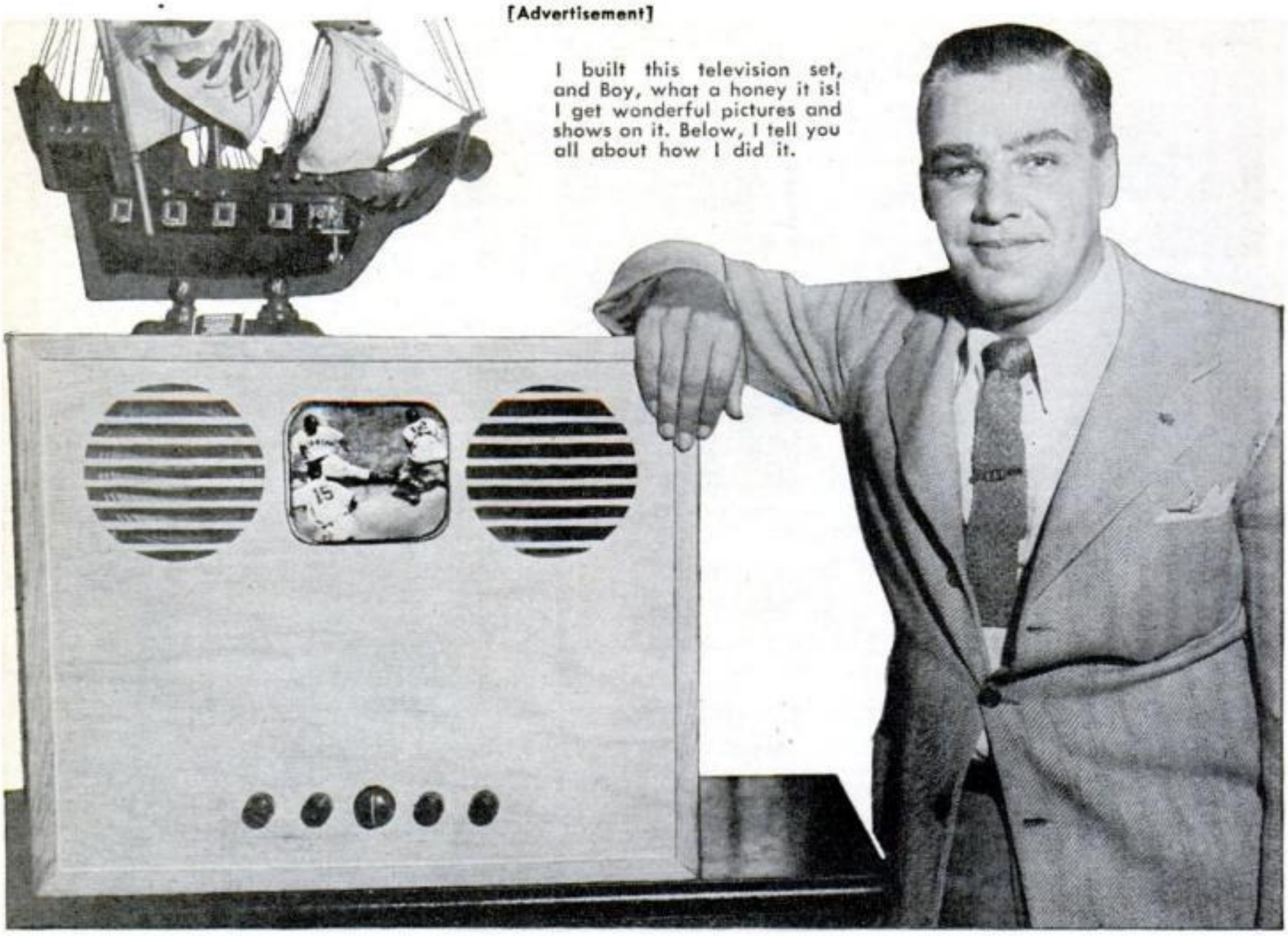
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I built this television set, and Boy, what a honey it is! I get wonderful pictures and shows on it. Below, I tell you all about how I did it.

How I Built My Own Television Receiver

By Bill Nagel

NOT so very long ago, television was a complete mystery to me. But not only did I build a complete television receiver chassis, but I had a lot of fun doing it. And I've learned so much that I'm well on the road to becoming an expert. In a few years I'll be able to "write my own ticket."

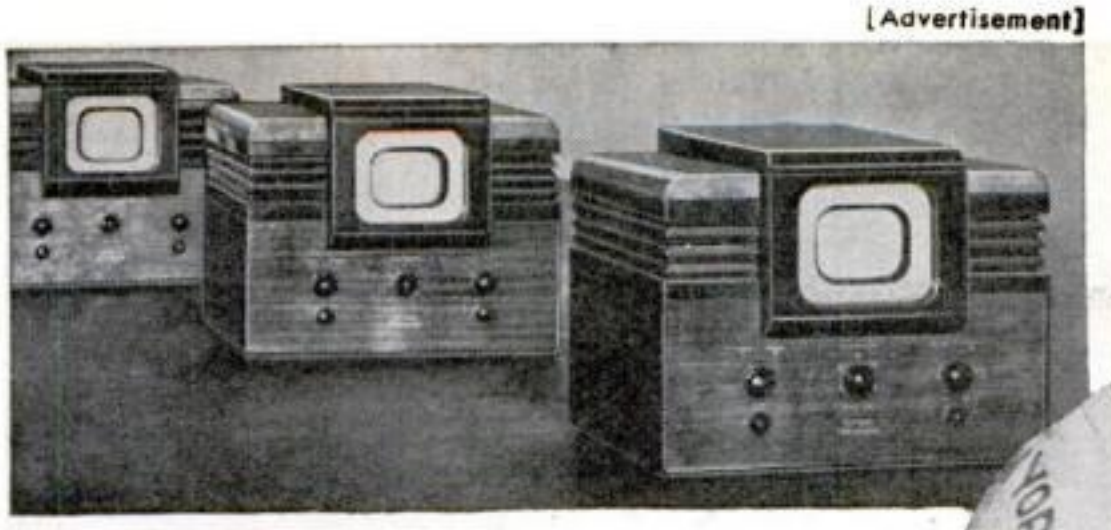


The students you see with me also built receivers. The picture shows us aligning our sets.

I always had a yen to get into television, even while I was in the service. But I didn't know just how to go about it—until I heard about N.Y.T.I. of N.J. I went there with my discharge papers, and they did the rest. They showed me how the Veterans Administration would pay up to $500 a year against my total educational expenses, under the G. I. Bill of Rights. This meant that I had to pay very little out of my own pocket. It's a big break for veterans like myself—especially when you get subsistence allowances in addition. And part-time jobs are easy to get so you can earn extra money. Of course, all of the students here aren't veterans.

What bothered me at first, was that my mathematics was kind of rusty. I soon found that the school had brush-up courses in math and even had facilities for teaching radio math from the beginning to students who had never had a high school education. I convinced them that I was sincere

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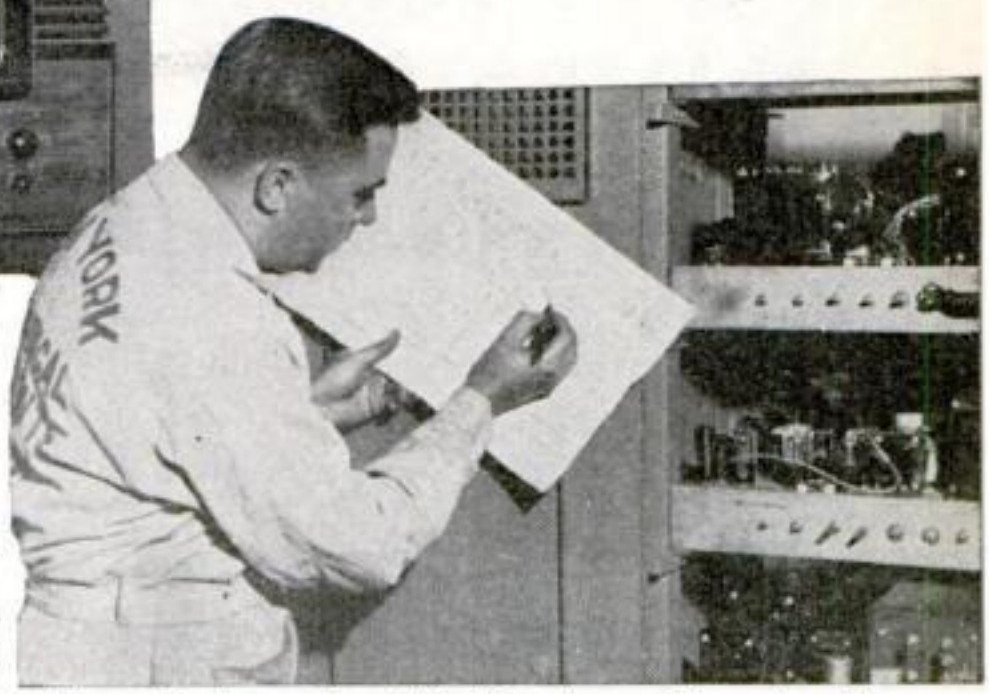
Here is a line of RCA television receivers that I and my fellow students use for comparative test purposes at N.Y.T.I. of N.J. The very latest equipment in television is ours to inspect and study at the school.

and enthusiastic and that I was technically inclined, and so I became a student. You know, you just can't build a television set right off. I built seven radio sets and had to go through a total of 75 electronic experiments, before they would even let me start on a television receiver.

Then I began work in earnest. The instructors around here have plenty on the ball, and it was **amazing how fast I progressed. Boy, school was never like this.** You should see the magnificent equipment. There's a swell gang here. They come from all over, because practical television schools are hard to find, and N.Y.T.I. of N.J. has a wonderful rep when it comes to television. I don't believe that you can find better training anywhere.

Another thing I like about N.Y.T.I. of N.J. (New York Technical Institute of New Jersey) is the convenient location. It's right in the *heart* of America's electronic industry, (Newark, N. J.), only 19 minutes from New York City. Big radio, television and electronics manufacturers are nearby—like RCA, General Electric and Edison. So are the big network stations like WJZ. WEAF and WOR. This means that the school is always right in touch with the latest developments.

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types of equipment. There is a great deal of individual instruction and the instructors know their business.

I am sure there are a lot of fellows, particularly veterans, who want to get into this field. I understand there are about 120 openings now for new day students in the classes beginning this November and December. If you want the complete dope about the school, you can have a free bulletin, which illustrates and describes its facilities and equipment. It also tells the classes that may be attended, housing conditions, costs, hours, etc. There is no charge for this bulletin. Just ask for Bulletin 311. Send your postcard or letter to the New York Technical Institute of New Jersey, 158 Market Street, Newark, N. J.



These are my class-mates (note that I am second from the left, standing) with the television receiver chassis they built at the same time I built mine. I built the cabinet at home later on. Most classes are small, so you are sure of a lot of individual instruction, which is very important in learning the technical side of television.

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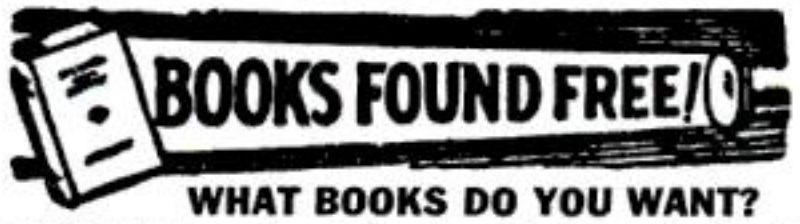
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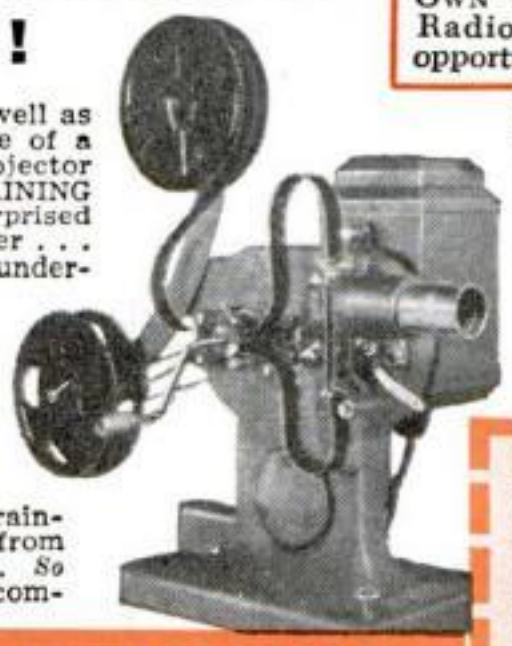
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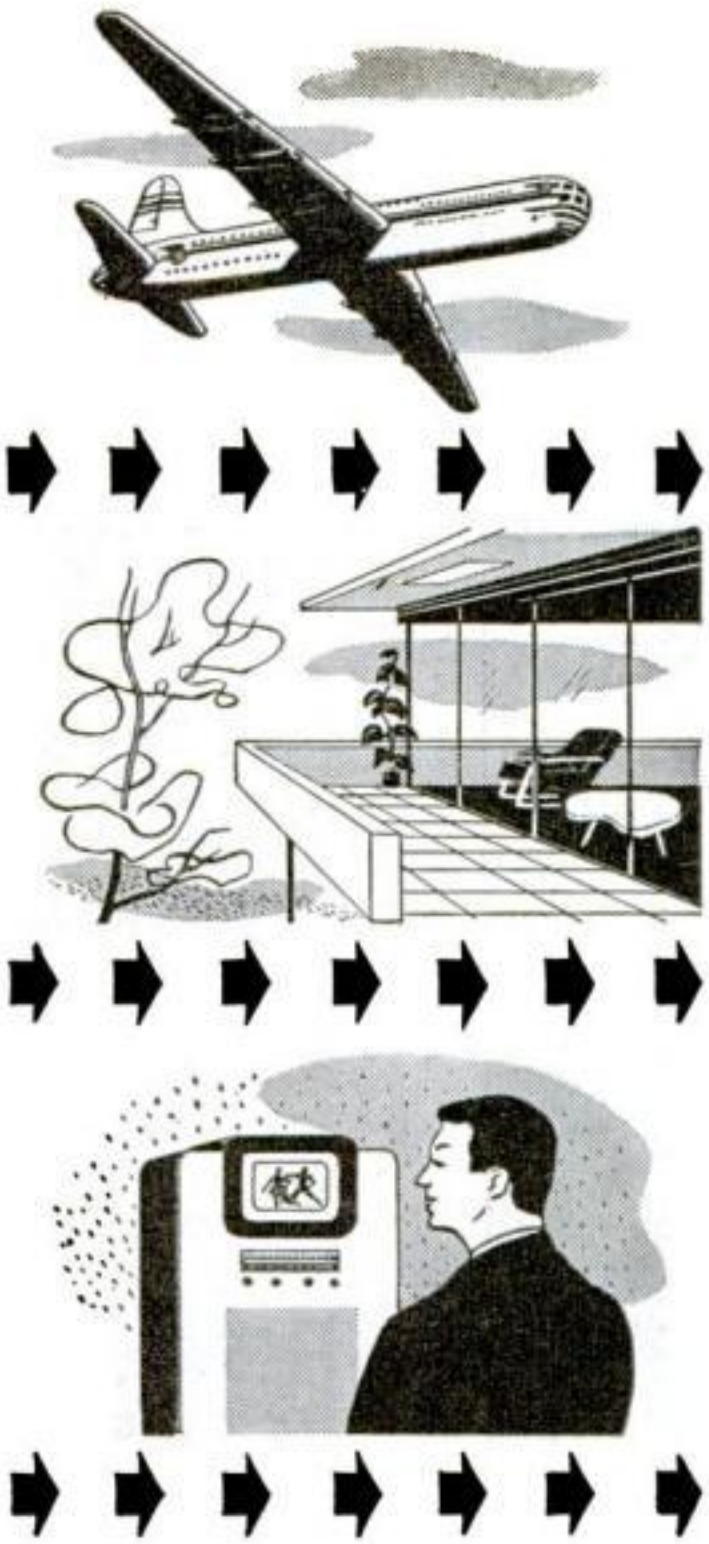
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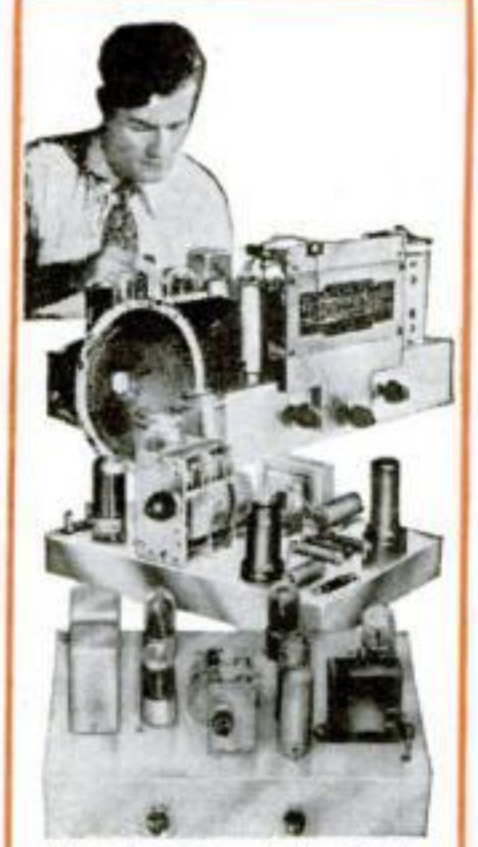
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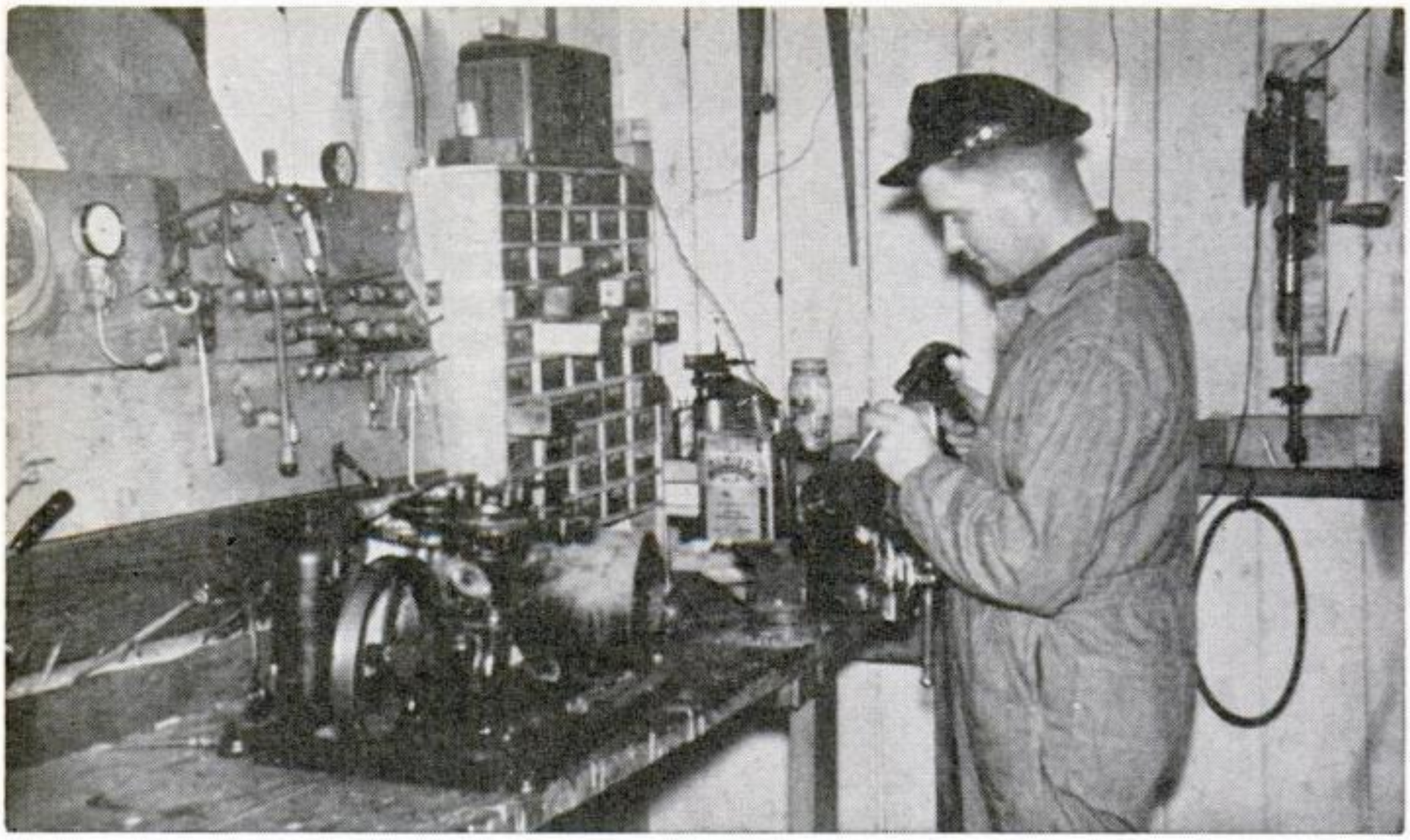
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By S. T. CHRISTENSEN

the "Fix-it Man"

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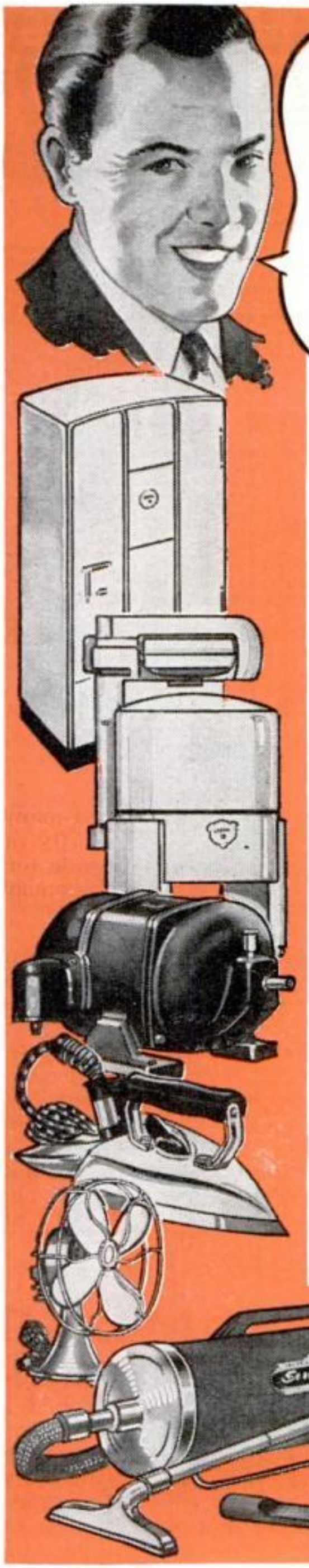
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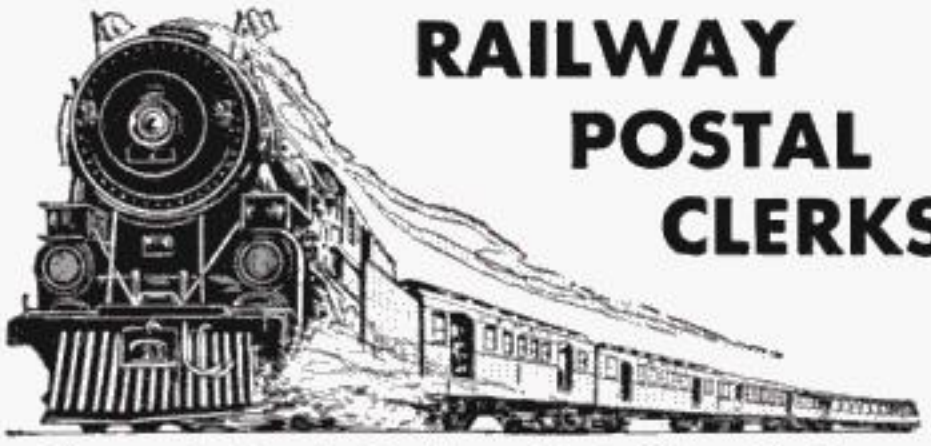
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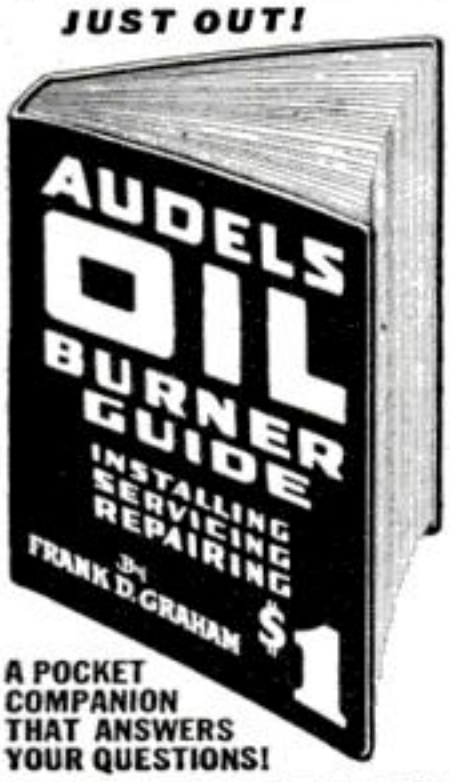
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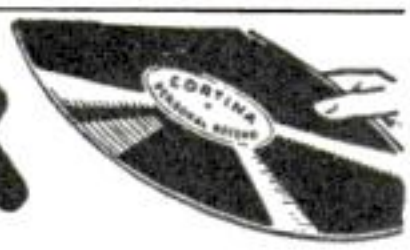
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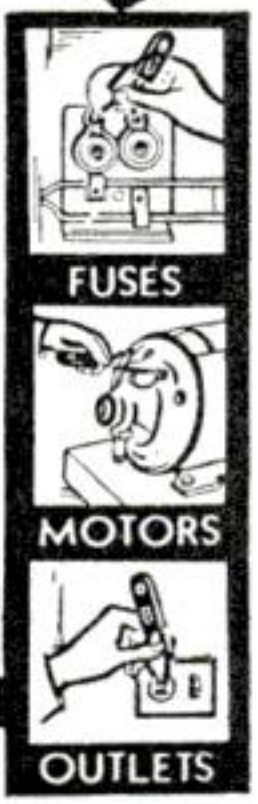
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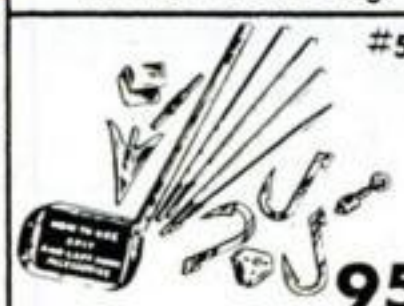
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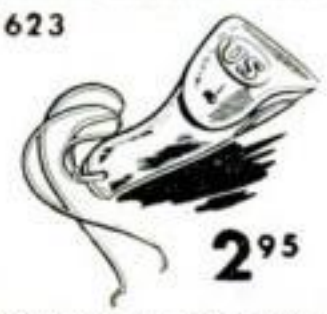

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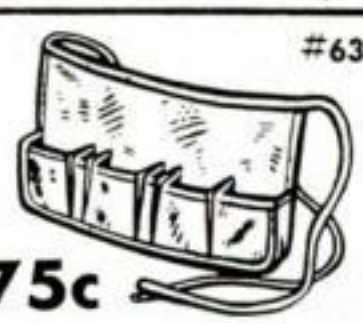
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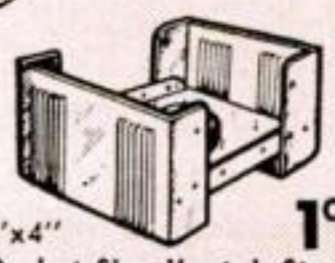

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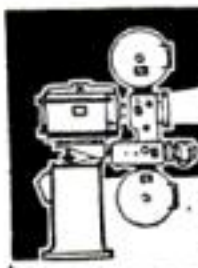
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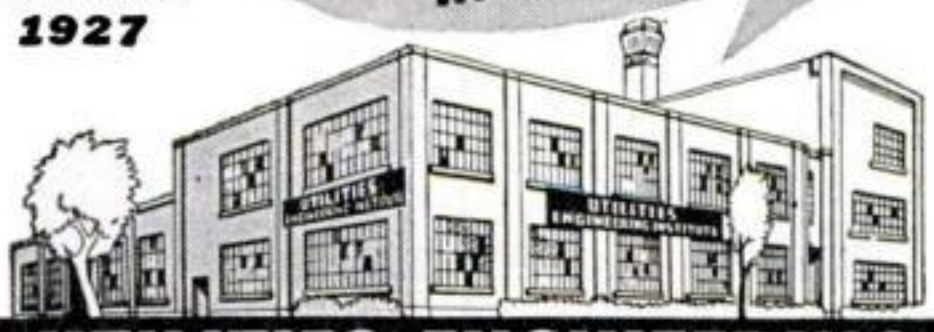
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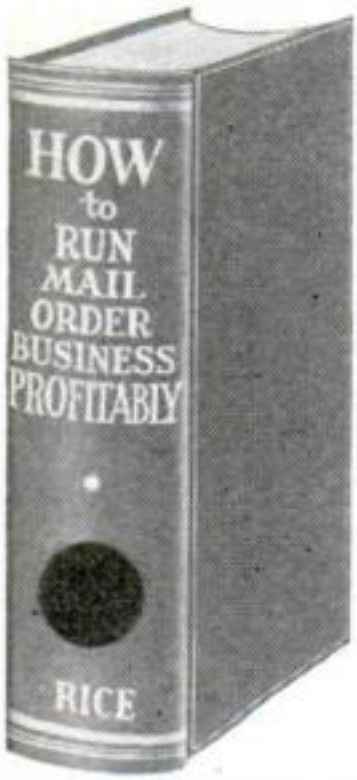


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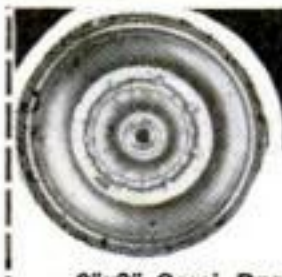
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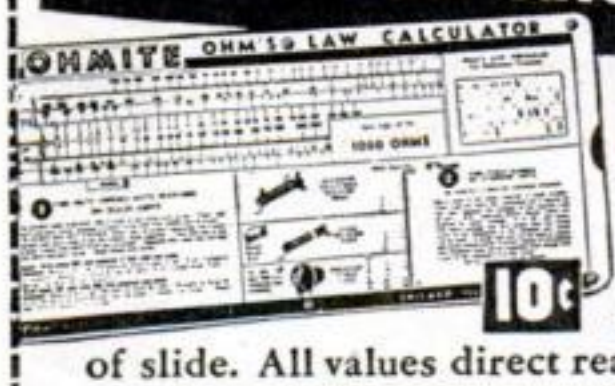
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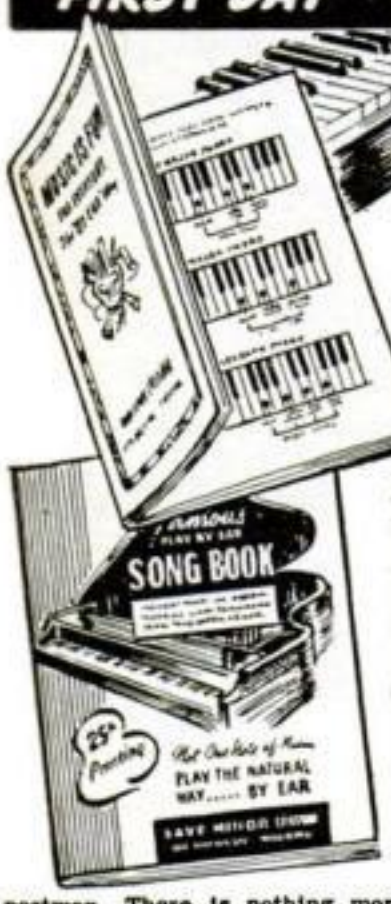
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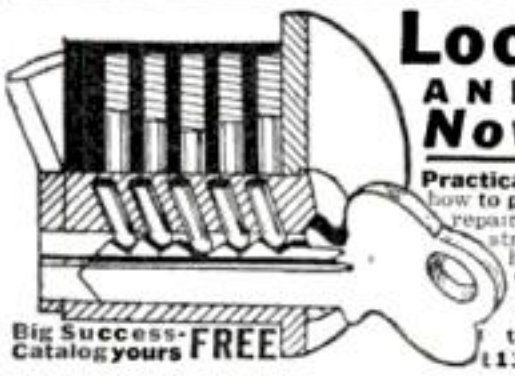
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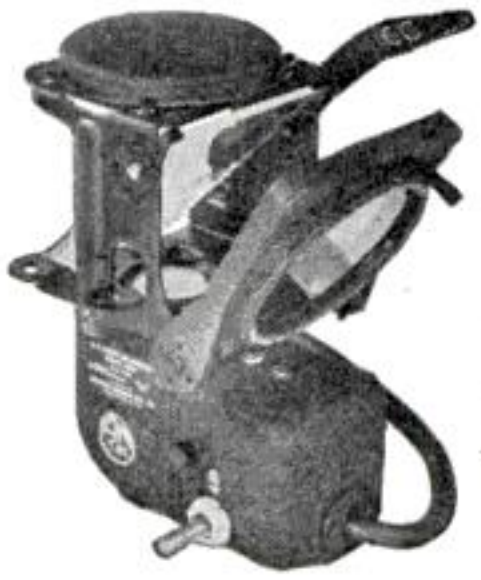
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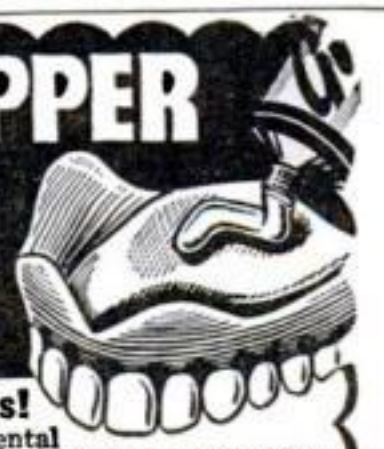
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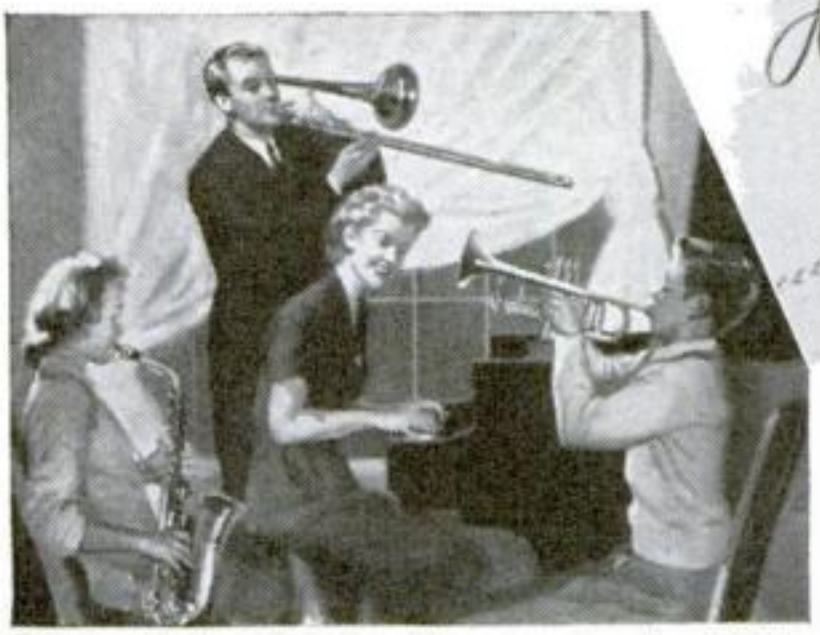
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POPULAR SCIENCE MONTHLY

NOV. 1946



BRINGING DOWN THE MOON

A high moment in the Hayden Planetarium's sky drama (page 132) comes when the moon is shown growing ever larger as it nears the earth preparatory to exploding and sending man into oblivion. The Hayden show realistically foresees five ways in which celestial forces could destroy the earth.

How New Cars Package People

IN DETROIT this month automobiles shrouded in muslin mystery were burning rubber on corrugated test tracks. For the American family that has been whetting its appetite for a new car for five straight years, this was an occasion—the machines being tested were the first crop of real postwar models.

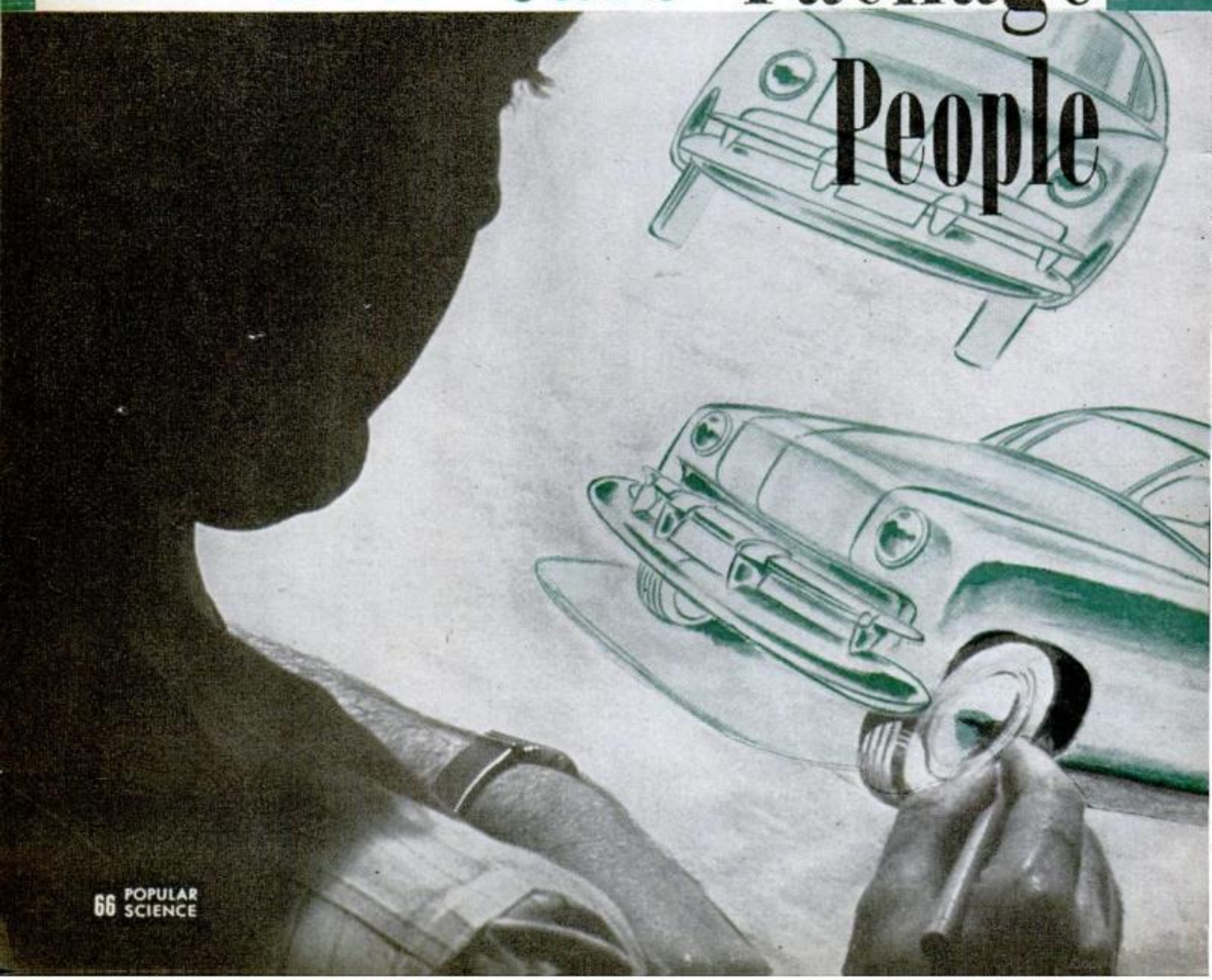
It was an occasion, too, for an automotive industry traditionally timid toward change. For the new models revealed growing recognition that the designer's job was more and more a matter of packaging people in motion. If millions of potential buyers could not yet see the exact curvature of the cowls, they could make a pretty shrewd guess—in the absence of an automobile show for the first time in a peacetime year—as to what the new cars would look like, inside and out.

They aren't dream cars made of plastic, but they have changed fundamentally—and for the better. Stylists are gradually abandoning the whip-socket philosophy of creating mechanical buggies and adding seats as an afterthought.

What they are doing is to give more elbow, leg and head room to human beings within an automotive framework of inelastic dimensions. And they are doing it without compromising performance, appearance or safety. The results are a fresh lesson in the utilization of space.

The new Fords are a case in point. They may well lead their price class in roominess when the 1947 models come on the market.

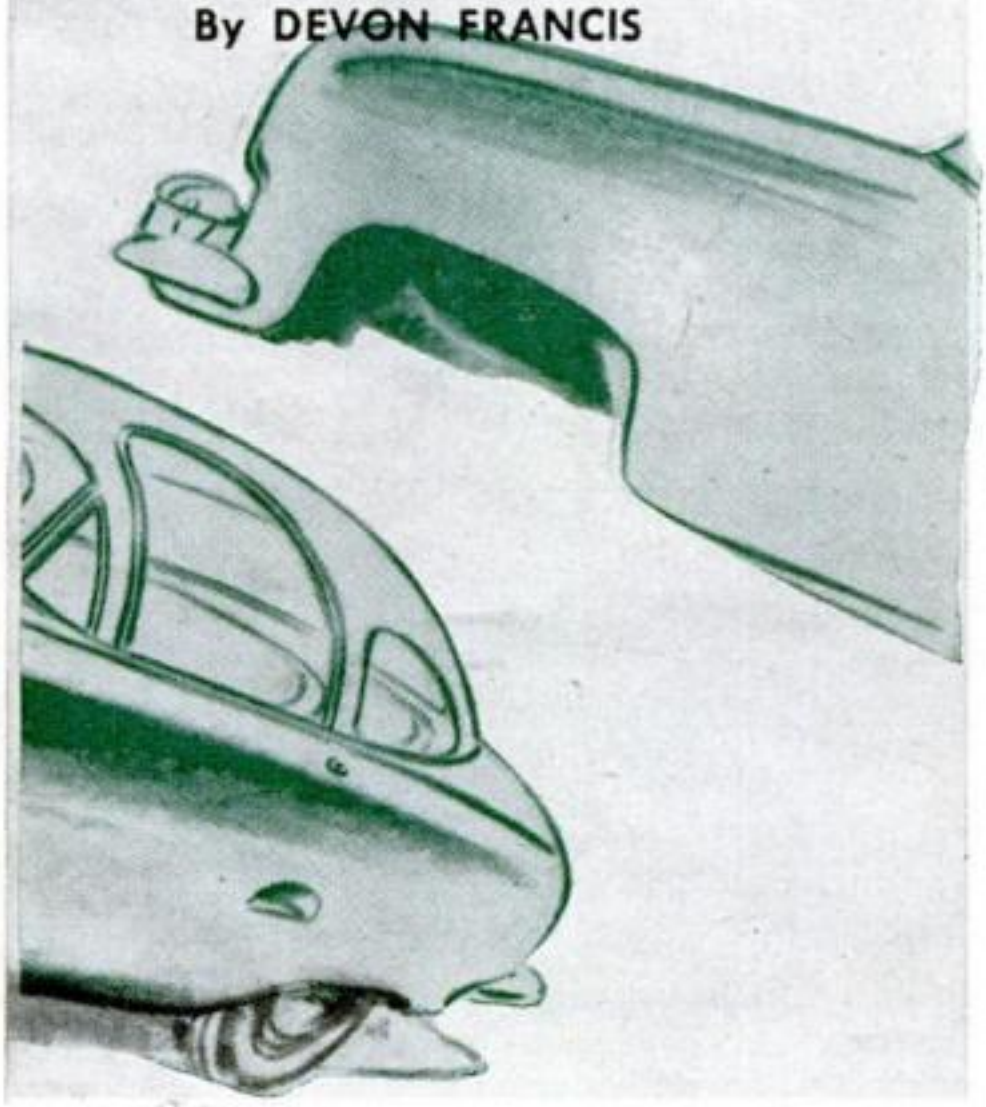
The Ford sedan casts an oblong "shadow" covering 115 square feet. But less than a third of that area can be used for the pas-





First true postwar models provide more room in better-designed bodies.

By DEVON FRANCIS



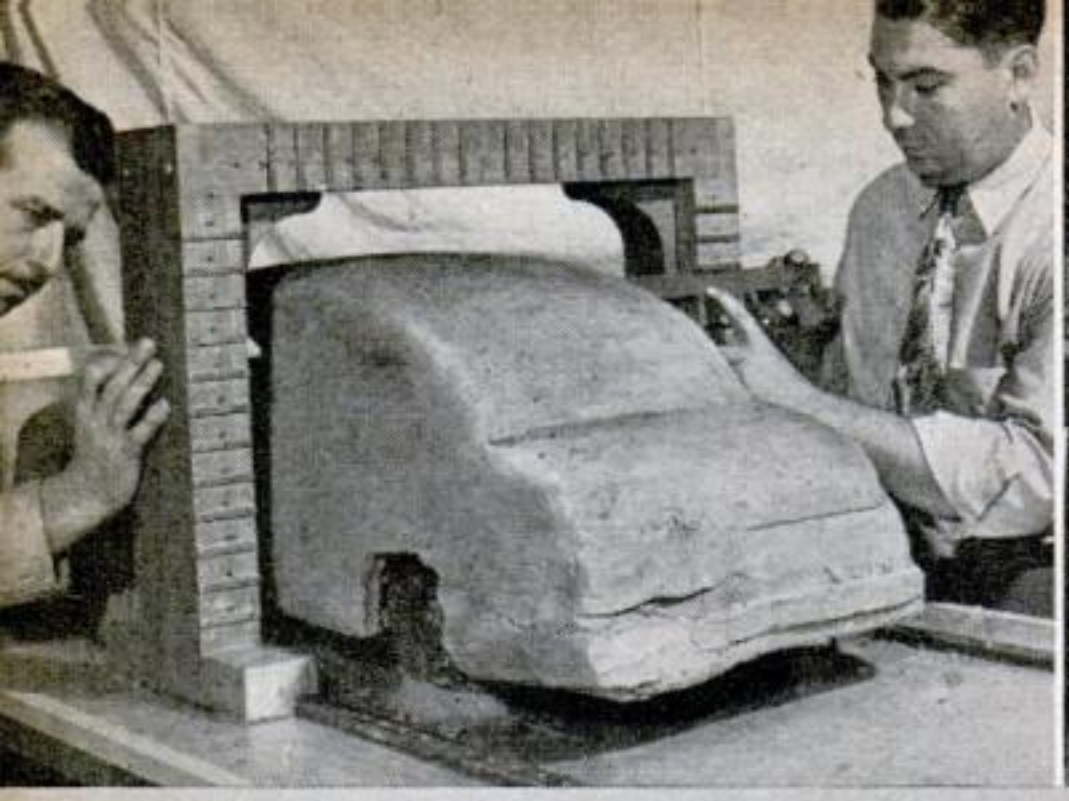
sengers. The rest of it is occupied by the motor, at least part of the transmission, wheels, body, bumpers, luggage compartment and what the stylists call "a bushel basket full of junk" behind the instrument panel.

Cars have a third dimension—height. The Ford measures 67 inches from the ground to the highest point on top. That's a lot of space, considering the fact that a person loses height by the length of his thighbone when he sits down. Fitting in the passengers looks easy.

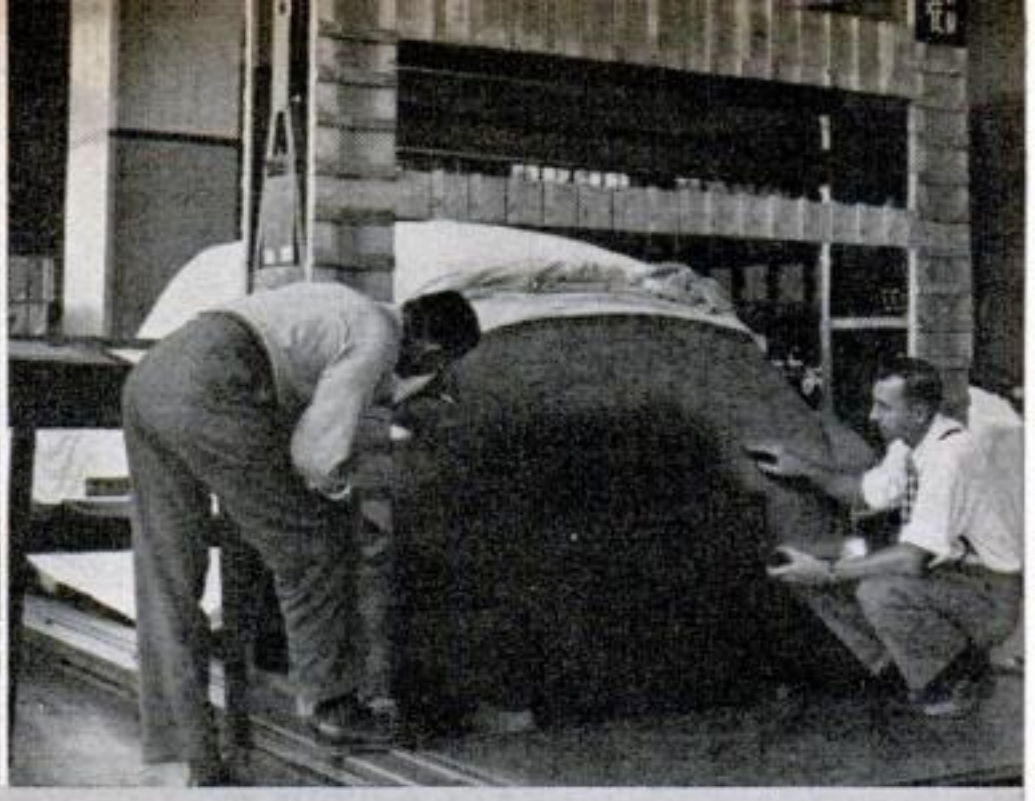
But the stylist runs squarely into that block of inelastic dimensions. A car must have road clearance of eight to nine inches so the bell housing on the transmission won't scrape on rutted roads or angular-slope driveways. A frame must be accommodated, and on the frame must go seats, and into the seats stuffing and springs for passengers' posteriors.

The top of the car must have thickness for strength and insulation and padding—passengers' heads must be protected when they get bounced on rough roads. Seats can be only so high with relation to the top of the car, or a person will knock his hat off

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This quarter-size Ford, roughed out in clay, is in the "scaling bridge" that divides model into one-inch squares for transfer of measurements to drawings.



Full-size clay model in large scaling bridge. Fender and deck are painted out to hide 1947 designs, prepared under direction of E. T. Gregorie, Ford stylist.

whenever he climbs in or out of the car.

If the stylist could draw a line under his problems at this point and tote them up, he would be happy. He can't. He also has to consider dimensions that are largely theoretical.

Passengers must have headroom. A six-foot man weighing 200 pounds will depress the springs of the seat, say, three inches, providing adequate clearance for his head. But a skinny six-footer will depress the springs only two inches. That reduces his clearance.

A five-foot woman weighing 100 pounds will depress the springs just enough to put herself at the right height behind the wheel for a proper line of sight over the bonnet of the car. But a five-foot woman uncommonly well-padded will sink down until she barely can see through the bottom of the windshield.

So the stylists compromise. They assume that a heavy person is a tall one, a light person a short one. Automotivewise, a dumpy passenger is just one of nature's unfortunates.

Faced with packaging the passengers in space that makes a Pullman compartment look like Grand Central Station, the stylists

Wood "seating bucks"—full-size models—are fitted with hardware for testing. This 1947 Ford door contains a novelty that is in plain sight—but you can't pick it out.



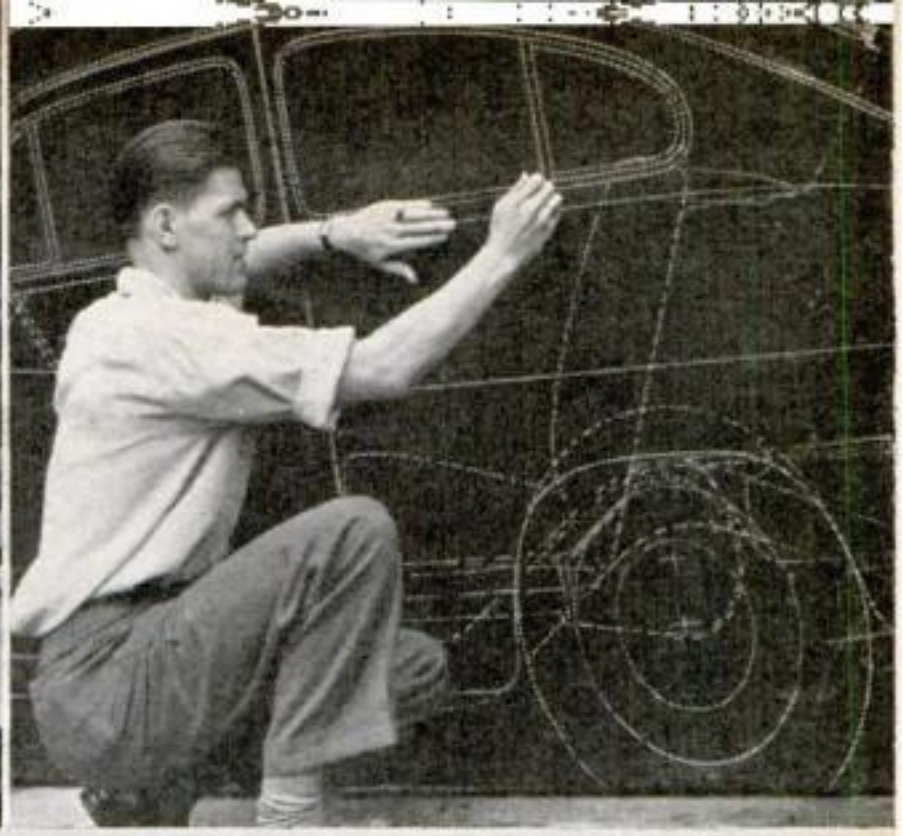
Feminine feet measure the four-inch span between experimental wood-faced brake pedal and accelerator. Girls test the controls and appointments of new models; men are too busy to do it.



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Only the wheels are real on this 1942 Mercury. The rest is clay modeled on a wooden frame and painted for full effect. "Chrome" is silver foil.



In tooling up, full-scale blackboard drawings must be transposed to engineering drawings. Later, dies for stampings are made.

hit on an average legroom in both the front and the rear seats. That's fine until a six-footer behind the wheel shoves his adjustable seat as far back as he can get it. Then a six-footer in the rear seat doesn't have room to stretch his legs.

Nonetheless, next year's cars will be bigger and roomier without lengthening the wheelbase. The stylists do that by increasing the "overhang" on the front and rear. Whereas at one time the snout of the engine was at the median line of the front wheels, today most engines rest immediately over the axle. The baggage and spare-wheel compartment extends far beyond the rear axle. The additional room increases the length of the passenger space.

At the same time, bodies are widening and with them the seats. The stylists achieve that by absorbing most, or all, of the fenders into the body. The exterior result is a squaring-off of the car's lines and more room. But it could not have been accomplished in the rear seat against the encroachment of the wheel housings unless something else had been combined with it.

Up front, the engine, clutch assembly and transmission housing used to be shut

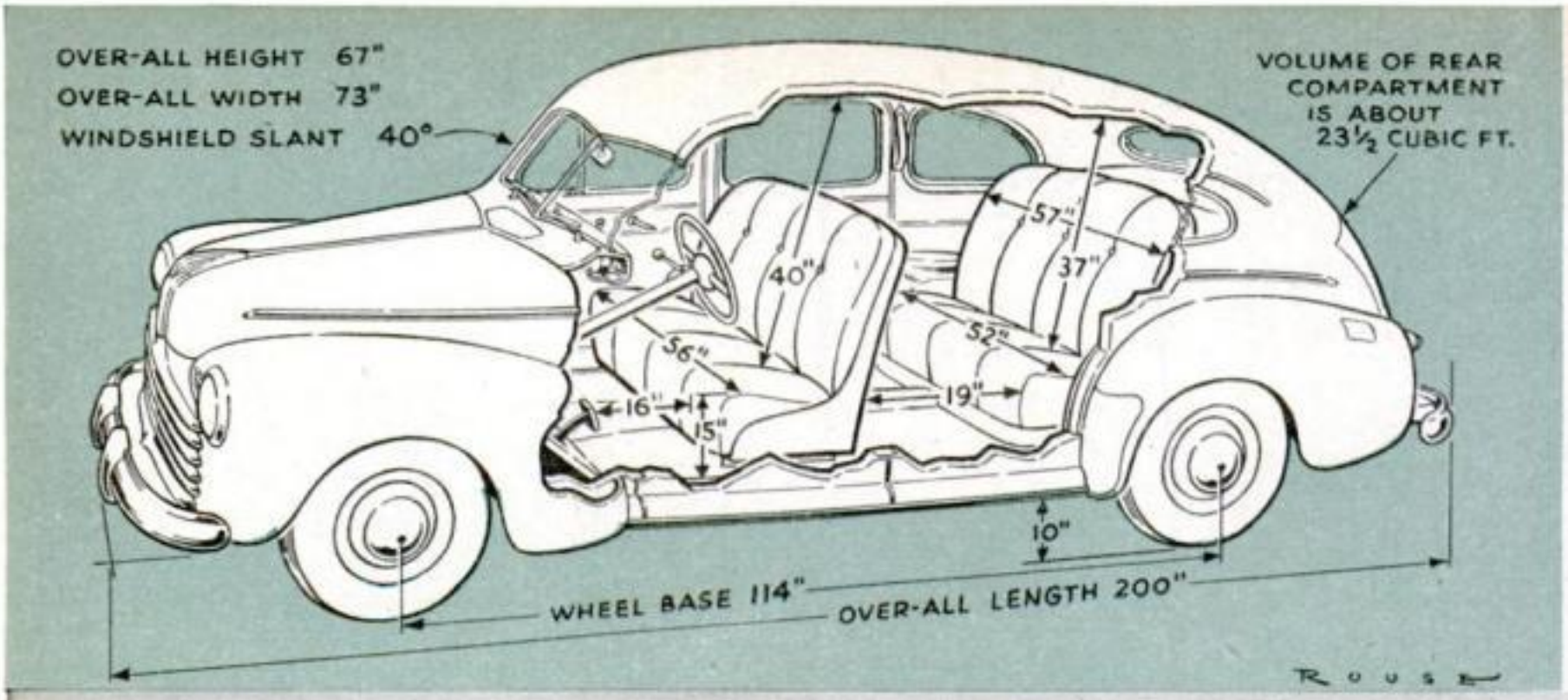
Rear seats are getting wider as a result of being shifted ahead of rear wheels, allowing use of full width of car. This mockup of a rear seat shows ample leg room and wide, deep windows.



Three average-sized persons must be able to sit side by side in the front seat. Ford artist has blanked out the instrument panel, a company secret at this stage of the game.



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Proper packaging means precise measurements. Allowable variation in most dimensions that control finished surfaces is only 0.1 inch. In this drawing, average distances are given for the dimensions that depend upon the position of the adjustable front seat.

away in front of the firewall and under the floor boards. Now the passenger space juts forward, and the separating partitions bulge inward to accommodate the machinery. This bulge is the hump that separates the accelerator pedal and the footroom on the right-hand side.

By thus robbing the room formerly allotted to the car's machinery, designers can move both the front and rear seats farther forward. As a happy by-product, the rear-seat passengers enjoy a smoother ride because they are cradled between the front and rear springs rather than being seated almost directly above the rear spring.

In reshuffling the entrails of the automobile, the stylists have been beset by the problem of lowering height. Sales departments keep demanding lower silhouettes. The machinery has to go somewhere as the roof comes down and the floor goes down with it. So, in many cars, a tunnel, or ridge, to house the propeller shaft leading to the differential has to be built into the floor.

Pillars Are Shrinking

Safety is another thing the designer has to consider in packaging his passengers. The pillars holding up the front of the roof must be strong enough to resist the impact if the automobile overturns, and yet narrow enough to eliminate blind spots. Pillars will be smaller next year. In some experimental cars they have disappeared altogether. Curved windshields are stressed to act as supports for the roof.

The windshield must be deep enough for a driver to see an overhead traffic light and yet shallow enough to retain the car's aesthetic appeal. The hood must be high enough for style and yet low enough for a person to see the road a few feet in front of his bumper. The rear window must flow into the rakish lines of roof and cowl, and yet be set at an angle to permit a clear rear view with the mirror.

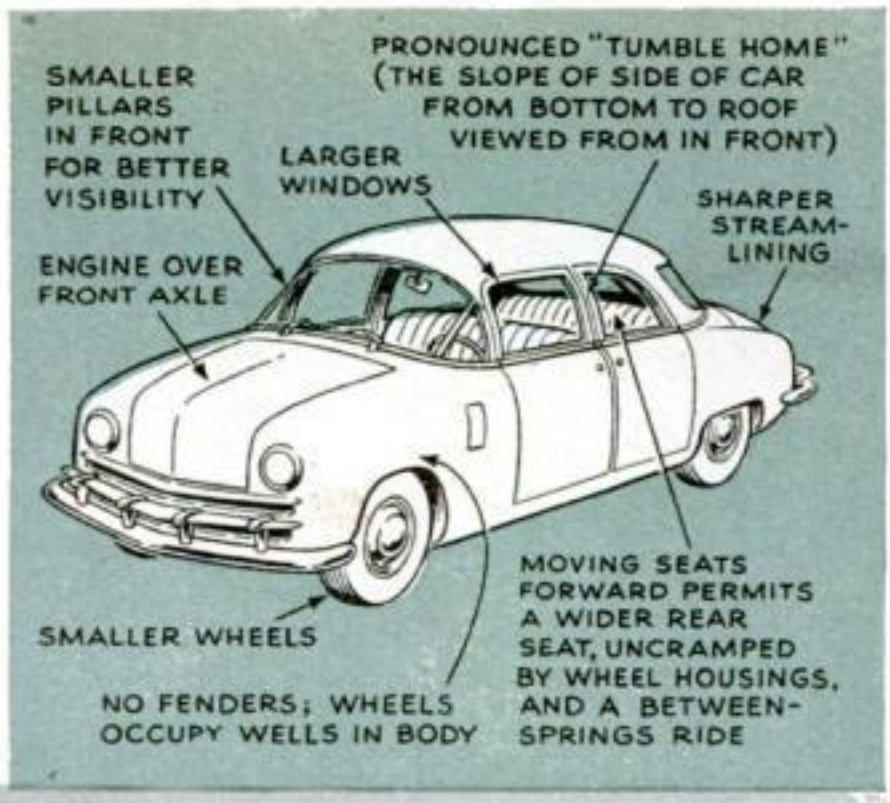
Comfort vs. Chrome

It has taken the automobile industry a long time to come around to a consideration of the passenger. For years looks were everything. Chrome sold better than comfort. The stylists did some cheating. They hid the discrepancy in width between the lip of the back-seat cushion and the backrest by installing wedge-shaped armrests, tapered from front to rear.

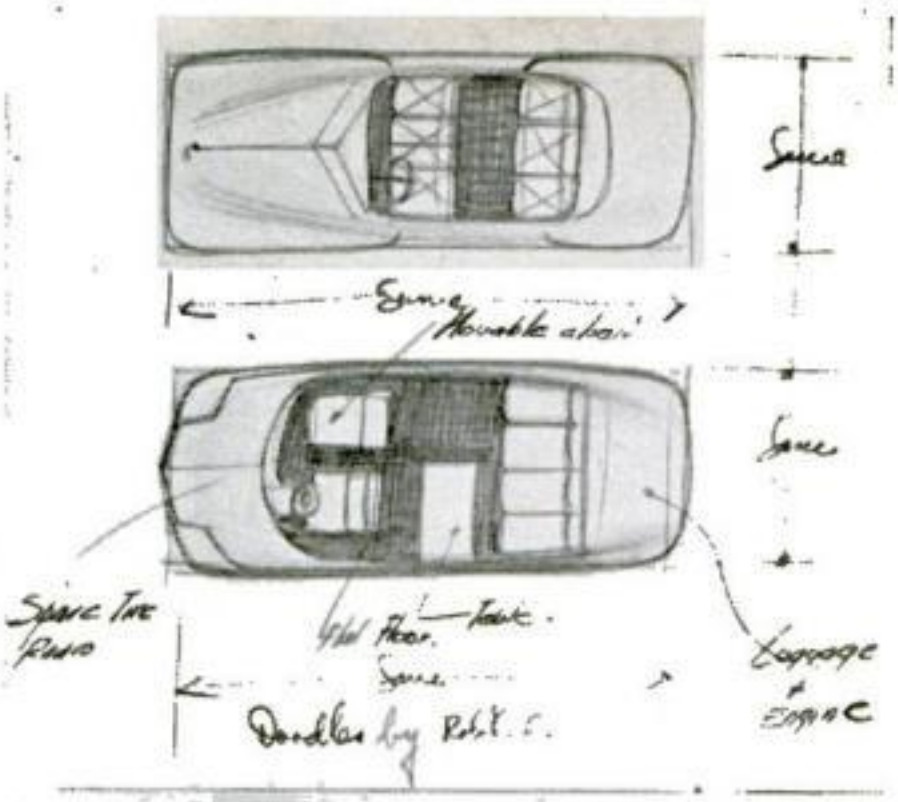
They exaggerated the "jackknife" in the seats—the degree of slope from the front of the cushion to the backrest. This provided additional headroom and permitted shrinking the over-all height of the car, but it also imposed an uncomfortable amount of the passenger's weight on his legs.

Designing that did not consider the packaging of passengers led to mistakes. One manufacturer tilted his windshield an extra two degrees for looks and received thousands of protests—at that angle it was a perfect mirror for the lighted dials on the instrument panel. Another put the front-seat ash trays at the ends of the instrument panel and

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Cars are lower, but extra-large wheels will be available for high-center roads. Other trends: larger windows, engine farther forward.



While talking with PSM reporter, designer Robert E. Bingman doodled these sketches to show seat space gained by placing engine in rear.

spewed ashes over the passengers when the forward ventilation wings were opened.

The Marmons and Auburns of the late 1920s had high cowls that were a delight to the eye but a pain in the neck to a man trying to see out. For years some cowl ventilators didn't ventilate because designers didn't understand the principles of air flow. It took more years to put flush-type controls on the instrument panel so a person wouldn't ram his head into a projection in a sudden stop. They still haven't done anything really constructive about reducing the glare of an oncoming car's headlights.

Inexpensive Innovation

The industry worries over minor innovations. An engineer for one of the major companies approached Detroit's unredeemed heretic, William B. Stout, the other day to ask about an electric push-button door opener that he had put on an experimental car.

"What did the research on that thing cost you?" asked Stout's visitor. Stout tried to keep a straight face.

"You know those buzzer locks they put on apartment-house doors that are opened by pressing a button?" he asked. "You can get one like the one on my car at any hardware store. It'll cost you 75 cents."

Some of Detroit's independent stylists insist that the plague of the industry has been a deliberate lack of imagination—that automobiles would be built differently if it weren't for the twin deterrents of inertia and fear. But they know that the twin necessities of sales and manufacturing are vital in this blue-chip business where no mistakes can be small.

The styling process is fixed. Rough sketches are made of proposed models. One-tenth scale drawings are made to check dimensions and proportions. Then an approved drawing is made from which a woodworking department makes a quarter-size wood frame. Sculptors cover the frame with clay and establish the contours. When the model is painted it looks as real as a parked car.

The routine is repeated in a full-scale model. Final changes are made in the contours and then offsets are taken to be transposed back onto an original full-size drawing. After new drawings are made they are ready for the engineering divisions, which tool up for production.

Planning for the Passenger

Critics of the system say the process ought to start with the passenger seats. Robert E. Bingman, one of the independent stylists, recalls wryly that it took him three years to argue one of the major manufacturers into dropping an armrest low enough for comfort.

Stout has built a frameless car that has a top three inches lower than a Chevrolet's and more ground clearance, and yet has five inches more headroom. (PSM, July '46, p. 84.) Its "shadow" is exactly that of a Ford, but it contains a third more passenger

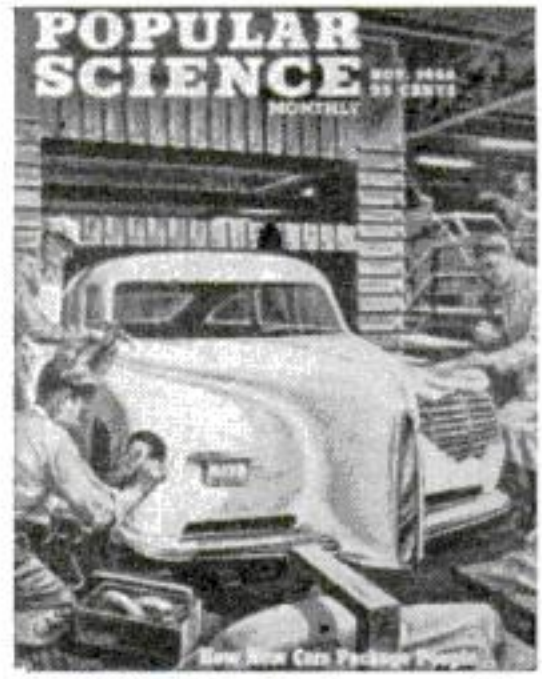
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space. Stout achieved this by switching his engine to the rear, robbing his luggage compartment of space and completely absorbing the fenders in the body.

Stout always has been in advance of his time. It seems inevitable that the rear engine presently will become standard in the industry. Pancake engines may speed the change.

The rugged individualists in design make out a good case for themselves. But so do the conservatives.

They say that if the manufacturers departed from what is known nebulously as the "trend," they might lose their shirts. In Detroit the Chrysler Airflow which appeared in 1934 is still referred to with shudders as a horrible example of departing from the trend, notwithstanding the fact that the new (and successful) Studebaker uses the same principles.



THE COVER: Under a scaling bridge, final touches are put on clay mockup of a new model. Painting by Ray Pioch.

But the industry's attitude is changing. For a major portion of the buying public, that means the attitude of the bigger manufacturers is changing. And give the small, less inhibited companies credit. They help nudge the industry along.

Behind the locked doors of every company's styling section are designs of yesteryear that never saw the light of day. They were ahead of the trend. Some of them are being dusted off now by stylists looking toward 1948.

WHAT DO YOU WANT IN YOUR NEW CAR?

HERE is your chance to express your preferences in styling and design. First, read the foregoing article to understand the limitations under which the designers work. Then check questionnaire below, sign, and mail to: Automobile Design Editor, Popular Science Monthly, 353 Fourth Ave., New York 10, N. Y.

CUT HERE

What do you like best about the design of your present car?

What do you dislike most about the design of your present car?

Do you want wider seats? Yes..... No.....

Do you want more shoulder room? Yes..... No..... Headroom? Yes..... No..... Legroom? Yes..... No.....

Would you pay extra for polarized headlights and windshields that reduce the glare of oncoming headlights? Yes..... No.....

Do you want more door entrance clearance? Yes..... No.....

Would you like windshield and windows bigger to afford more vision? Yes..... No.....

Is the instrument and control grouping on current cars satisfactory? Yes..... No.....

Would you favor putting the engine in the rear if it gave more seat room? Yes..... No.....

Do you want a greater over-all height in your car? Yes..... No..... A lower over-all height? Yes..... No.....

Do you regard the rear seat in a sedan only as an "occasional" seat? Yes..... No.....

Are current car speeds fast enough to satisfy you? Yes..... No.....

Would you favor eliminating the posts supporting the top in front at the expense of some structural strength? Yes..... No.....

Would you favor a driver's seat that was adjustable up and down? Yes..... No.....

Do you have difficulty in parking and backing cars of current design? Yes..... No..... If you have answered "Yes," is this because of bad visibility....., too much overhang....., or too great a turning radius.....?

Do you favor more ornamentation (chrome radiator grills, etc.) and less accent on seating arrangements? Yes..... No.....

Would you favor safety belts, like those in planes, as standard equipment? Yes..... No.....

Would you want washable, interchangeable summer and winter upholstery that zipped on to the seats? Yes..... No.....

Would you pay extra for hydraulically or electrically operated windows? Yes..... No.....

Would you buy a car with a much shorter wheelbase, such as some European models, if it were less comfortable? Yes..... No.....

How many years have you been driving?.....

What make of car do you own?.....

Its type..... Year of manufacture.....

How many miles has it been driven?.....

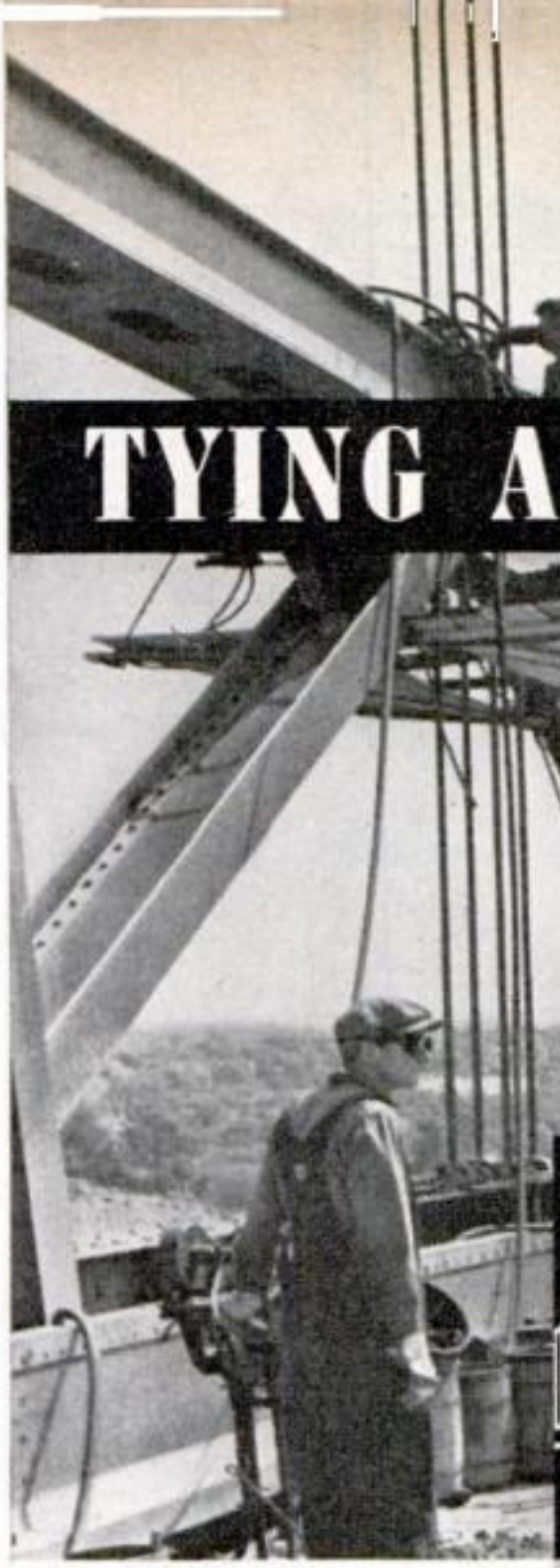
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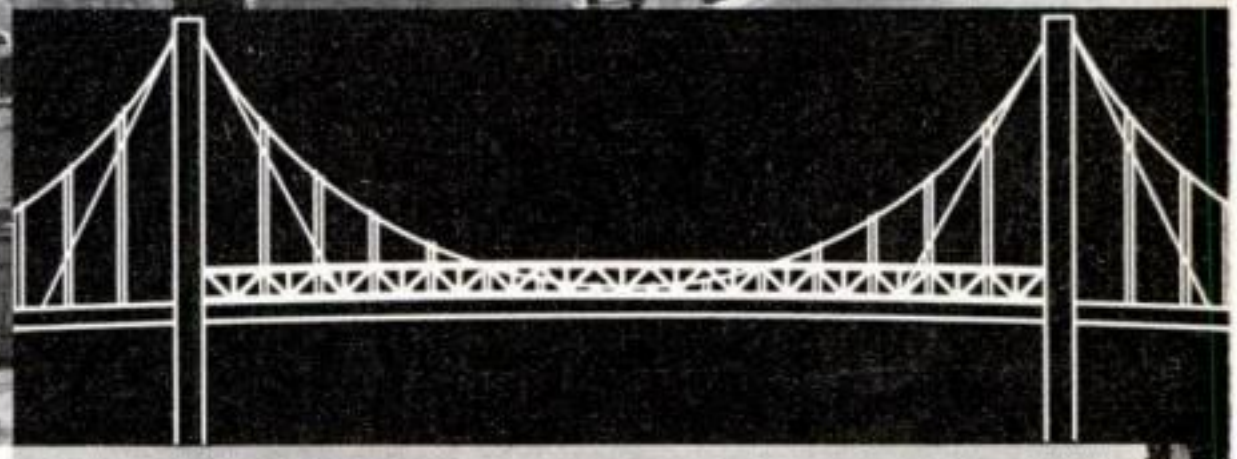
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TYING A BRIDGE DOWN







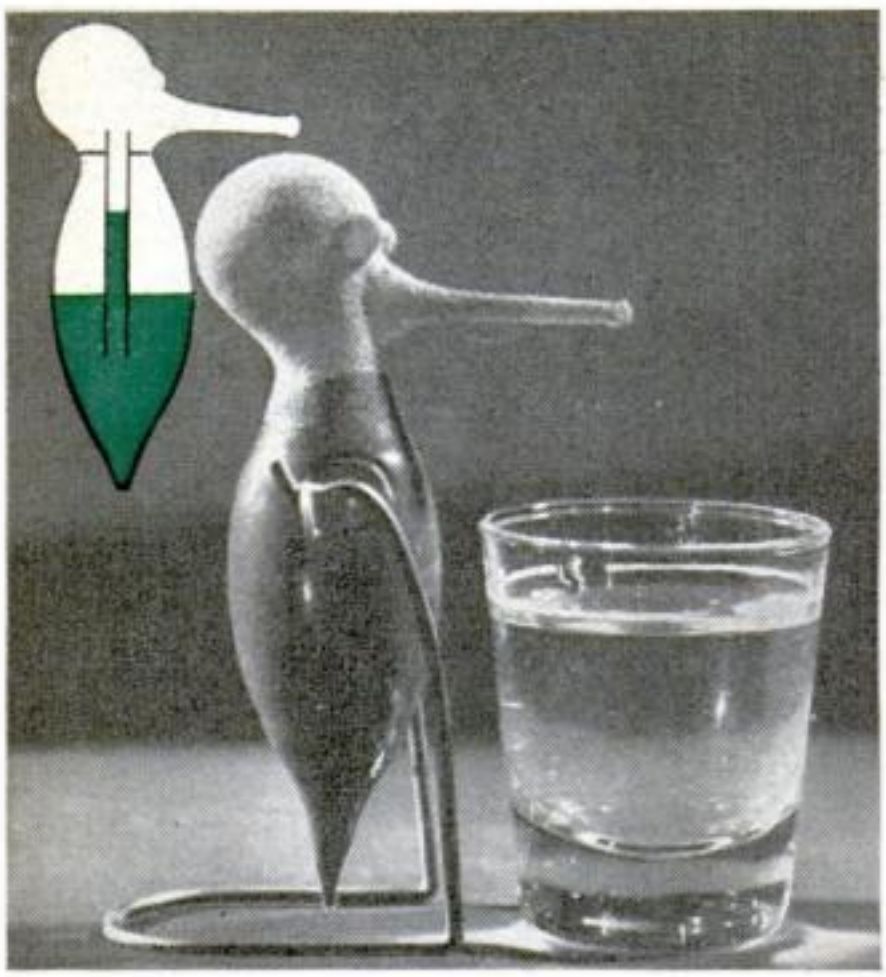
New York's graceful Whitestone suspension bridge is being reinforced again to reduce its swaying. The span is shown at the right before the heavy steel girders were riveted to both sides of the widened roadway from tower to tower, as shown in the illustration above, at right. Workmen above are pictured during the trussing job. Work is to be completed this fall, but a new paint job may have to wait for spring; winter winds make work on the bridge too dangerous.

ON WINDY days and during periods of heavy traffic, Whitestone suspension bridge, which links New York City's Bronx and Queens, began to reveal a sway with a rise and fall of as much as 14 inches shortly after it was finished in 1939. The bridge, nevertheless, was pronounced safe. One month after the Tacoma Narrows bridge, a similar structure, collapsed into Puget Sound on a windy day in 1940, however, steel cable stays were installed on Whitestone's towers to stiffen the span. Originally the bridge was built to carry two lanes of traffic each way. But soon the roadway was found to be inadequate. Now the pedestrian walks have been eliminated and two more traffic lanes opened up. The added load, however, again accentuated the oscillation, and the new network of reinforcing girders was ordered. The 2,300-foot bridge was chosen by the American Institute of Steel Construction as the most beautiful finished in 1939.

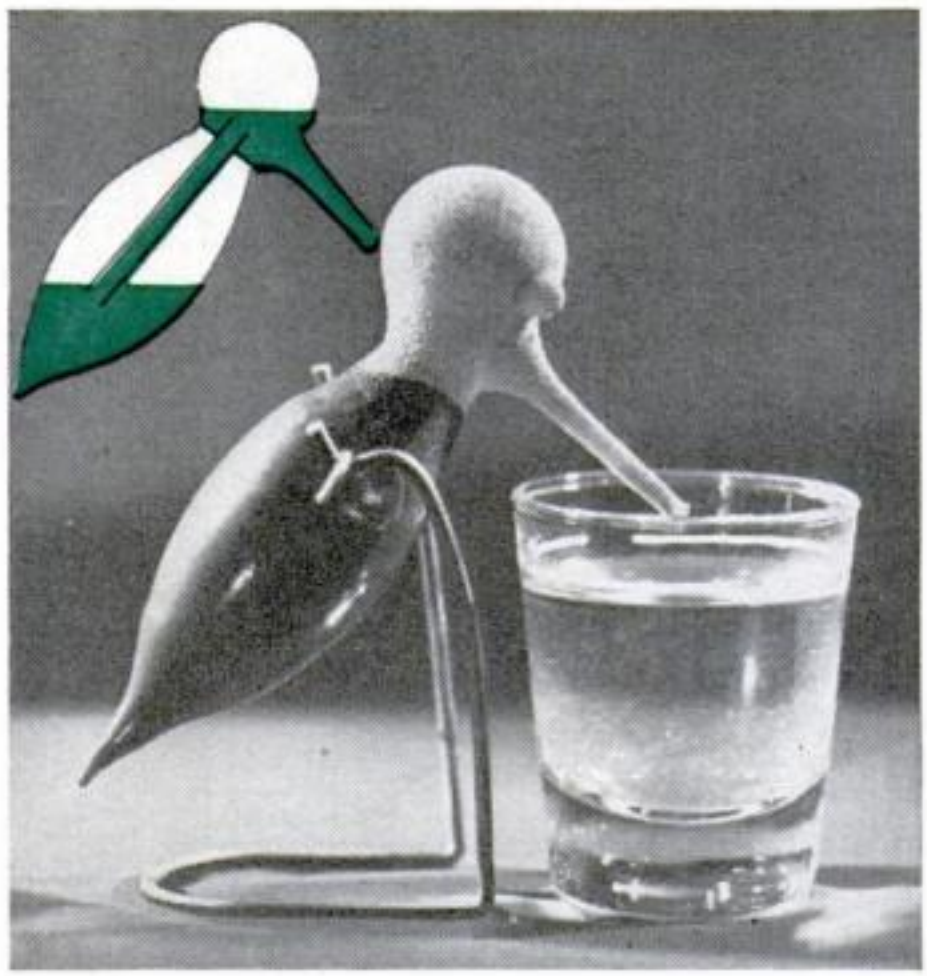
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PERPETUAL MOTION?

Mystery Drinking Bird, new scientific toy, comes close.



1. This little glass bird just drinks and drinks and drinks—nearest thing yet to perpetual motion. Insert shows division of head and body into compartments connected only by glass tube. Body is filled with liquid methyl chloride. To start the "Mystery Drinking Bird" on his spree, head is pushed into water. Capillary action wets entire head-cover.

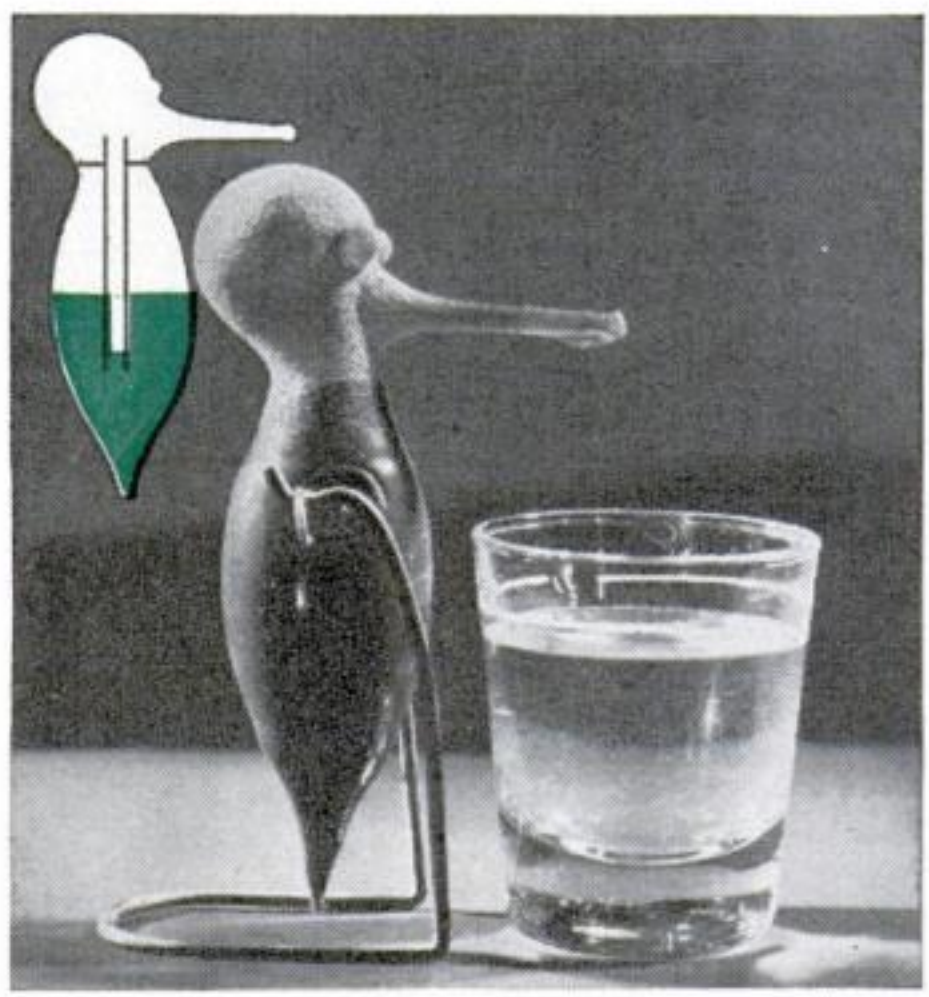


2. Methyl chloride vapor that had risen through tube to head has been condensed by cooling effect of evaporation of moisture in cloth head-cover. Condensation lowers vapor pressure in head and greater pressure of vapor in lower compartment forces liquid up through tube into head and beak. This tips bird forward to drink.

3. When bird has tipped all the way over, liquid seal in tube is broken and vapor in body can flow into the head. This equalizes pressure so that liquid methyl chloride runs back into the body, pulling bird's thoroughly soaked head out of water. The bird drinks whisky faster than water, since alcohol evaporates more quickly.



4. Flow of liquid into tail has brought the bird upright. Now water picked up by his head covering is evaporating again and soon he'll take another drink—and keep on as long as there is liquid in the glass. A fan turned on the bird speeds up evaporation—and drinking. The same principle will be used in a clock and a toy motor boat.



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NEW WAYS of Finding Things

Science is providing new new methods to help man more about his world. The reports this and the next two pages reveal how experts are letting their heads save their legs in exploring the wilderness for mineral wealth, mapping soil areas quickly and easily, and prospecting for oil under the sea.

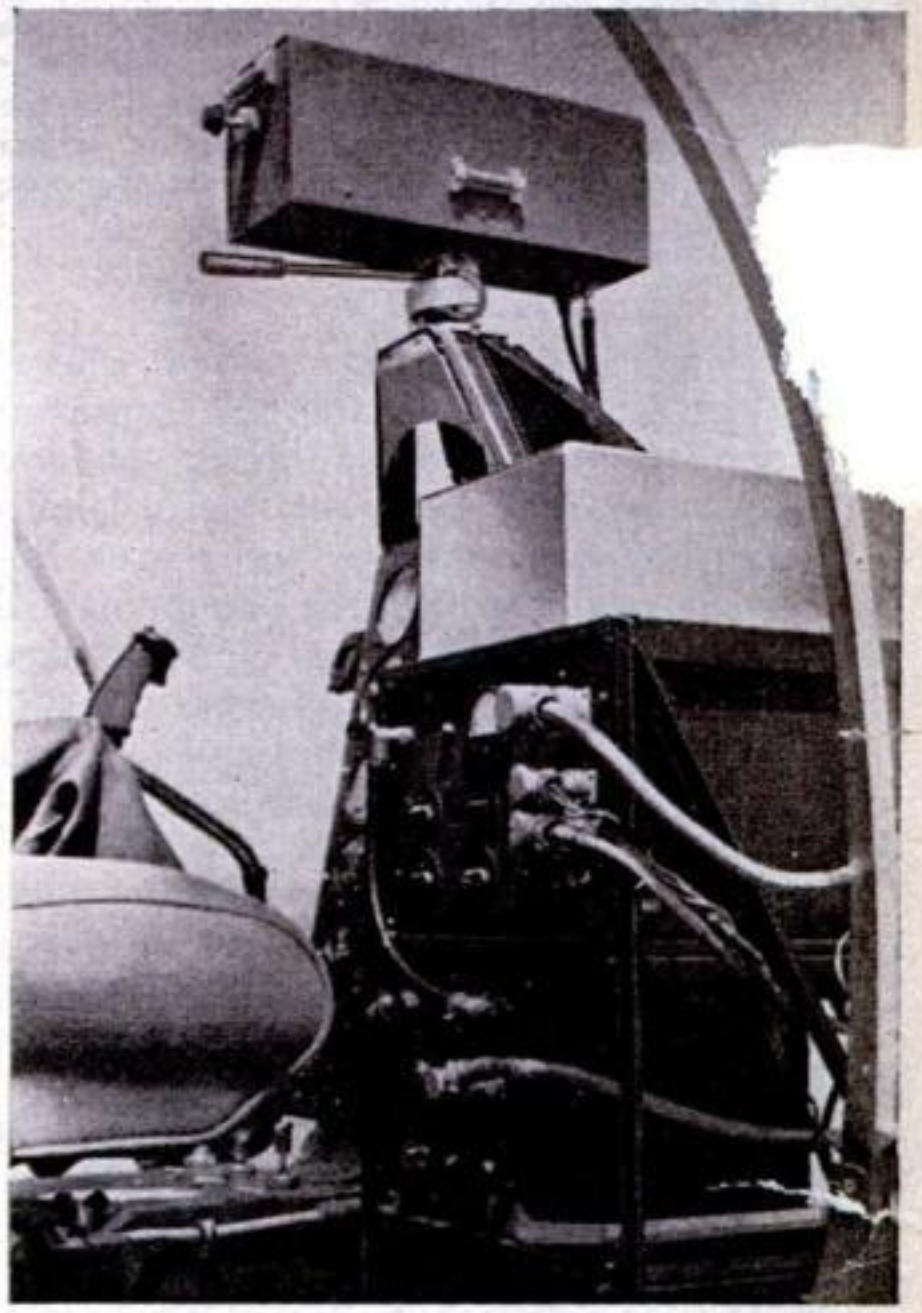


Prospecting by Helicopter

DOES more mineral wealth lie hidden in the rugged wilderness of northern Canada? Using a Bell helicopter and a magnetic detector, Hans Lundberg is finding out. In two hours, one of his best surveys covered ground it had taken 180 days to go over on foot.

Lundberg uses his own invention, a "magnetometer," similar in principle to the U. S. Navy's Magnetic Airborne Detection (PSM, Aug. '46, p. 128). Magnetic sources in the earth are registered on an electronic recorder as the helicopter flies along a previously plotted course. When ore is indicated, a white marker is dropped and rock samples are later collected there. Normally, an area two miles square is covered in a single survey.

The helicopter can land on muskeg, water, ice and snow. With floats (as above) it can drop safely on one-eighth-inch ice. This winter Lundberg will put skis on it for work in northern Ontario.



Equipment in helicopter's nose includes (top to bottom) pickup, recorder, distributor and amplifier.

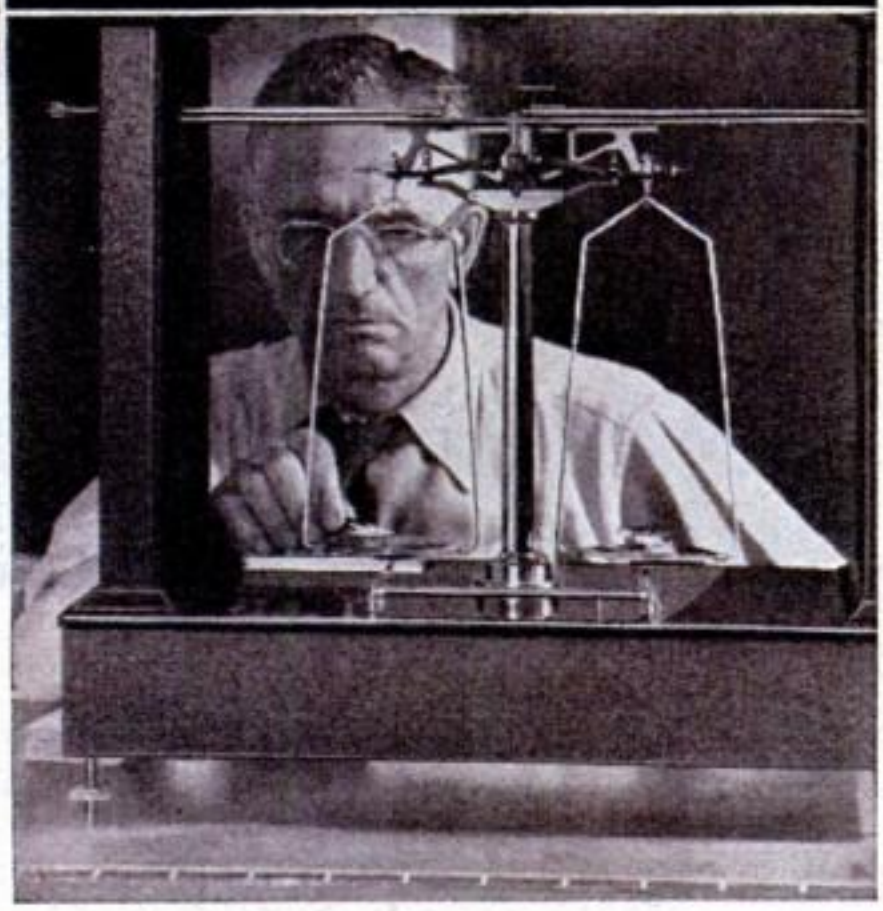
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NEW WAYS of FINDING THINGS





Surveying with Scales



Upper right: District conservation expert filling in soil and slope data on an aerial map after studying the area on the ground. Above: After the various types of soil have been noted and their areas outlined, the various pieces are cut apart along the outlines like a jigsaw puzzle. Right: Each piece or group of pieces is then weighed in a sensitive balance and the result compared to the weight of the map of the entire section, whose area is known. The resulting ratio gives the area of each piece of land being measured.

HOW much of what kind of land, where? That's the question the Soil Conservation Service must answer in laying out farm conservation plans. Once that meant laborious measurement with tape and transit, followed by equally lengthy mathematical computations. Now, in the Milwaukee office of the Soil Conservation Service, the job is done with an aerial camera and a pair of scales. And it is handled in a fraction of the time and labor formerly required.

Aerial maps of many farm regions, each covering two and one-half square miles on a scale of four inches to the mile, already exist. When farmers organize a Soil Conservation District, an expert goes over it on foot, noting on the air picture the various kinds of soil, amount of erosion and degree of slope. Then he outlines on the map the area covered by each condition.

Here comes the tricky part. Instead of the time-consuming job of figuring the acreage of each of these irregular pieces, the whole section sheet is weighed on a delicate balance and its total area measured by calculations based on its circumference. Each outlined segment is then cut out and put with the others of its type, and the individual groups are weighed. The area of each soil condition can now be figured by a simple ratio: The area of the type will be to the area of the whole as the weight of the various pieces of map showing this type is to the weight of the whole map. The area of any individual segment can of course be found by weighing it separately.

Soil Conservation experts consider the weight method not only quicker but more accurate. The allowance for error does not exceed one-half of one percent.

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Diving for Oil

IS THERE oil under the sea? American geologists are determined to find out. Using the latest diving techniques and radar, Standard Oil Company of New Jersey technicians are now exploring the ocean's bed.

Scene of this submarine prospecting is a 2,000-square-mile area in the northwestern Bahamas, out in the Atlantic opposite the end of Florida. Gravity meters are used to study the rocks underlying the sea to determine whether they are an oil-bearing type. The meters, together with an operator, are lowered to the ocean floor in a two-ton diving chamber. The depth in most places is less than 20 feet.

The prospecting crew of 20 men live afloat for six weeks on their radar-equipped ship, then return to their West End Island base to rest and go over their data. When they are at sea, radar allows them to plot their position accurately. If they find signs of oil, overwater rigs for drilling tests will be erected.







At top: Radar targets like this enable the und sea prospectors to plot their position accurate The position of the targets is known, and when th are picked up on the radar screen of the sear vessel their bearings provide a fix.

Above: The 112-foot *Stanba*, veteran of the submarine patrol, is now the prospecting ship. two-ton diving chamber is hoisted up at the st

Left: Looking down into the diving chamber at a trip to the bottom. The gravity meter beside t operator determines the type of rock under t sea by measuring variations in the pull of gr

Below: In especially shallow areas the prosp use this shallow-draft airboat. With an airpl motor and rudder, it can operate in less than inches of water.



AVIATION reports

THE first full-dress exposition of aviation —what it has done, is doing and will do —is to be held in Cleveland, November 15 through 24. Pictured here are the themes, displays and floor plan of this exposition: the first annual National Aircraft Show.



A. Atomic energy is theme of education and science section.



B. The International Bazaar; daily exhibits by world's air lines.



D. Helicopters will demonstrate uses of rotor-winged planes.



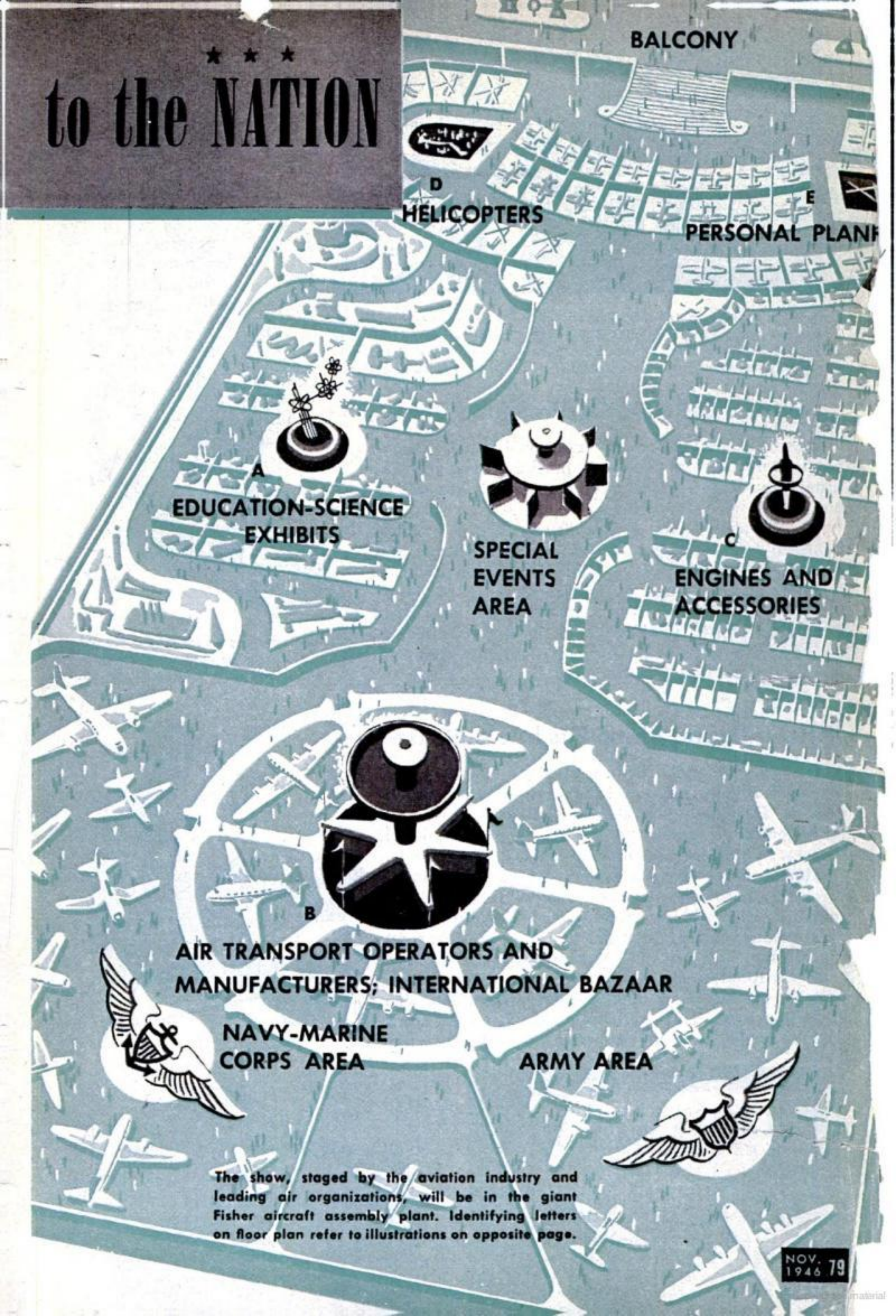
C. Rocket symbolizes future in engines and accessories exhibits.



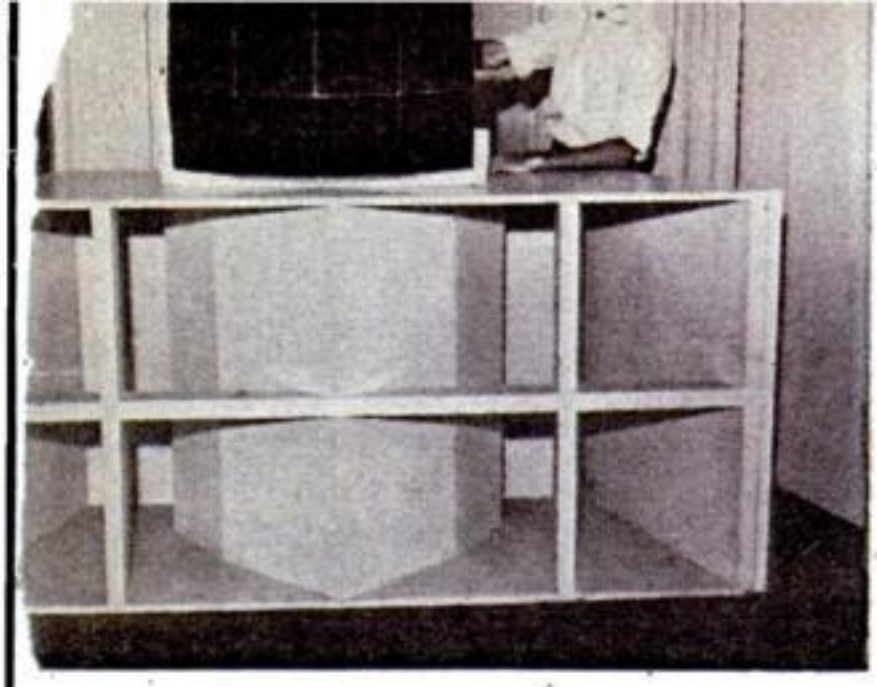
E. Model land-sea airport featured in private-plane area.

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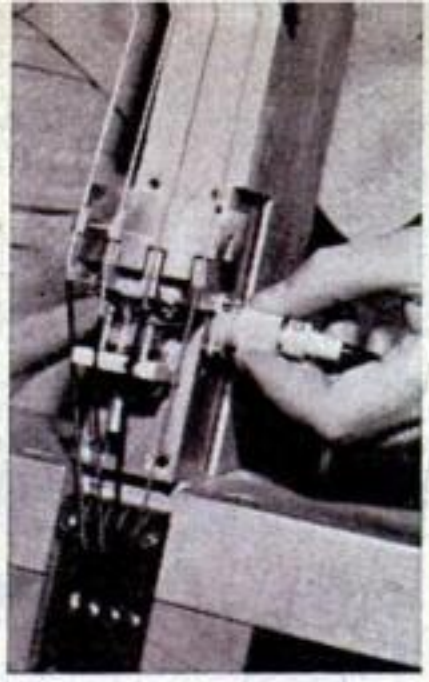
★ ★ ★ to the NATION



The show, staged by the aviation industry and leading air organizations, will be in the giant Fisher aircraft assembly plant. Identifying letters on floor plan refer to illustrations on opposite page.



Current from electro-cello is divided into three frequency groups: 40-300, 300-3,000, and 3,000-14,000 cycles. A separate loudspeaker turns each group into sound.



Cantilever aluminum bridge bends under string vibrations, transmits pressure to crystals.



Dr. Benioff plays his invention. Heavily built of maple to confine vibration to strings, instrument weighs 25 pounds.

Electric Cello Needs No Sound Box

TINY crystals replace the traditional wooden sound box in a new electrical cello. A musician plays it in the usual way, but produces more sound with less effort—and over a wider tone range.

The vibration of the strings distorts crystals attached beneath. As these alternately expand and contract they produce a variable voltage current. Amplified, this is transformed into sound by loudspeakers.

The new instrument was invented by Dr. Hugo Benioff, California Institute of Technology seismologist. He says that both cellos and seismographs deal with vibrations—one type fast, the other slow.

Fifteen-Pound Piano Fits Into Suitcase

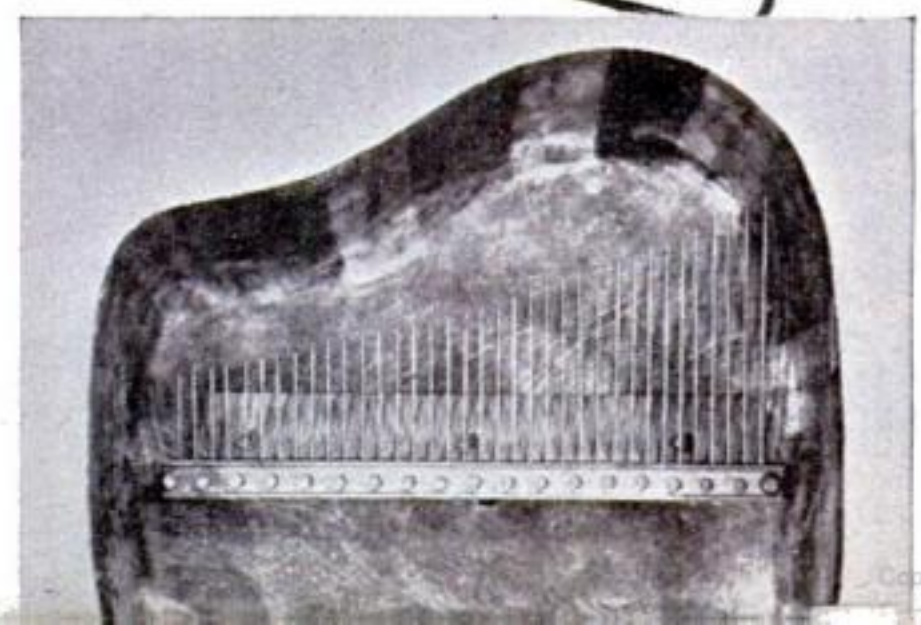
THE suitcase piano, shown at right with inventor Harold B. Rhodes, has only 150 parts and weighs but 15 pounds. Designed to be taken to the bedside of wounded veterans to encourage them to exercise injured muscles by playing, it is now in civilian production.

Aluminum replaces wood, the three-octave keyboard is plastic and the one-piece lid is molded Fiberglas. The hammers, shown below, strike special alloy rods, below right, instead of the usual strings. The rods never get out of tune. The price will be about $75.

Ex-GI Rhodes made his first model with scrap from a B-17. He also developed a short-cut method, disregarding scales and exercises, to teach convalescent soldiers to play tunes in three weeks.







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At left, Navy mechan bridle a fighter to th shuttle car that w launch the plane. Th hold-down unit is bein attached at rear. Thi will break when plan takes off. Below, trac on which car travels.

Electric "Slingshot" Launches Plane

Photos by Westinghouse

Quarter-mile-long electric motor cuts take-off run 85 percent.

By GEORGE H. WALTZ, JR.

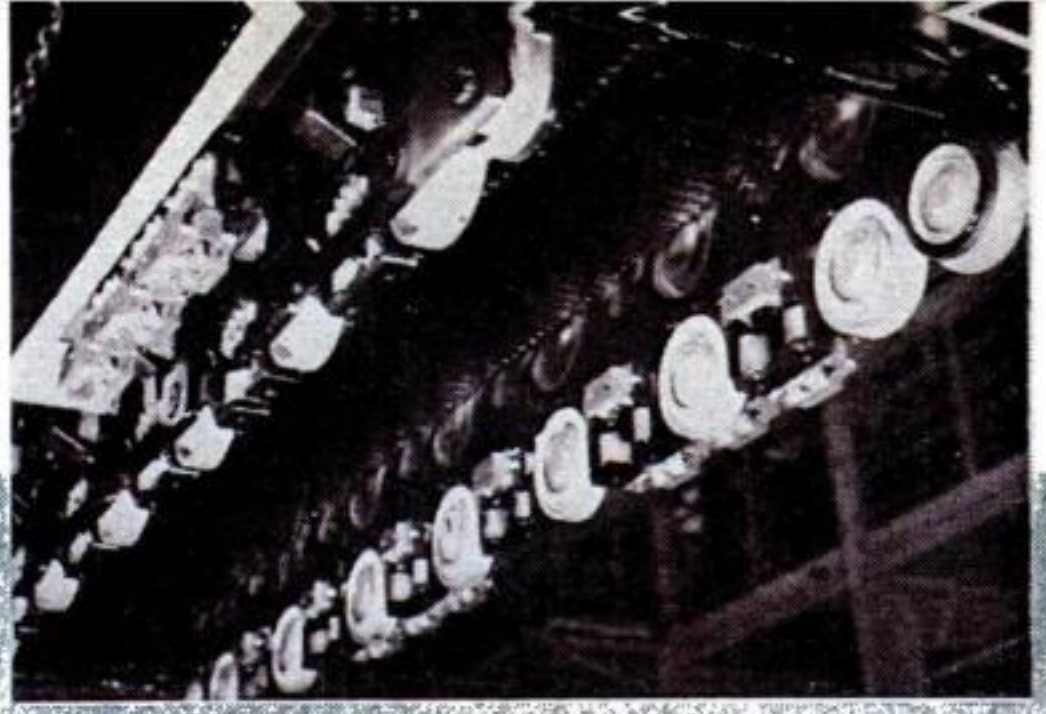
ELECTRIC "slingshots" may soon be launching giant passenger sky liners from postage-stamp airfields and roof-top city airports. Two such devices at naval airports can now get airplanes as large as B-17s and B-24s into the air in a few seconds with take-off runs of less than 500 feet. And they do it so smoothly that passengers zoom to 120 m.p.h. in that distance with no more discomfort than if they were home in bed with their feet in the air!

The "electropult," as the new electric catapult has been dubbed by the Westinghouse Electric Corporation, which developed it for the Navy, is a flat electric motor more than a quarter of a mile long. Instead of rotating, the motor's moving part—an airplane launching car—streaks down a tracklike runway (the flat motor's stationar part) to boost a plane into the air in le than a sixth of its normal take-off run.

When a plane is to be launched it i hitched to the motor's launching car with a conventional catapult bridle, and restrained from moving forward until the proper moment by a standard hold-back and release cable. Both are regulation gear used in all types of catapult launchings. When the plane's engines have been brought up to their full power, a surge of electric current is fed to the flat motor. The initial forward electromotive thrust of the launching car



The launching car contains the coils and steel cores ordinarily found in the stator of an induction motor. Bit in front holds wire bridle that hooks under plane's wings.



The underside of the shuttle car. The rows of brushes outside the wheels are the insulated collectors that pick up the current. The grillwork down the center is the primary core.

READY FOR TAKE-OFF

D-BACK ICE

CAR IN STARTING POSITION

TAPULT FICER'S TROL

WHEN PILOT SIGNALS "READY" CATAPULT OFFICER SIGNALS MASTER CONTROL STAND TO CLOSE AC CIRCUIT TO PRIMARY WINDINGS IN CATAPULT CAR

CAR TOWS PLANE AT RAPIDLY INCREASING SPEED. CAR IS INDUCTION MOTOR'S PRIMARY

EMERGENCY CONTROL PIT

1,100-HP. RADIAL AIRCRAFT ENGINE

AIR DUCT FOR AIRCRAFT ENGINE

COOLING FAN

DC GENERATOR

BUS BARS IN TUNNEL CARRY CURRENT TO RUNWAY

CONTROL STAND FOR AIRCRAFT ENGINE

CONTROL CABLES

MASTER ELECTRICAL CONTROL STAND

DC MOTOR RECEIVES CURRENT FROM DC GENERATOR

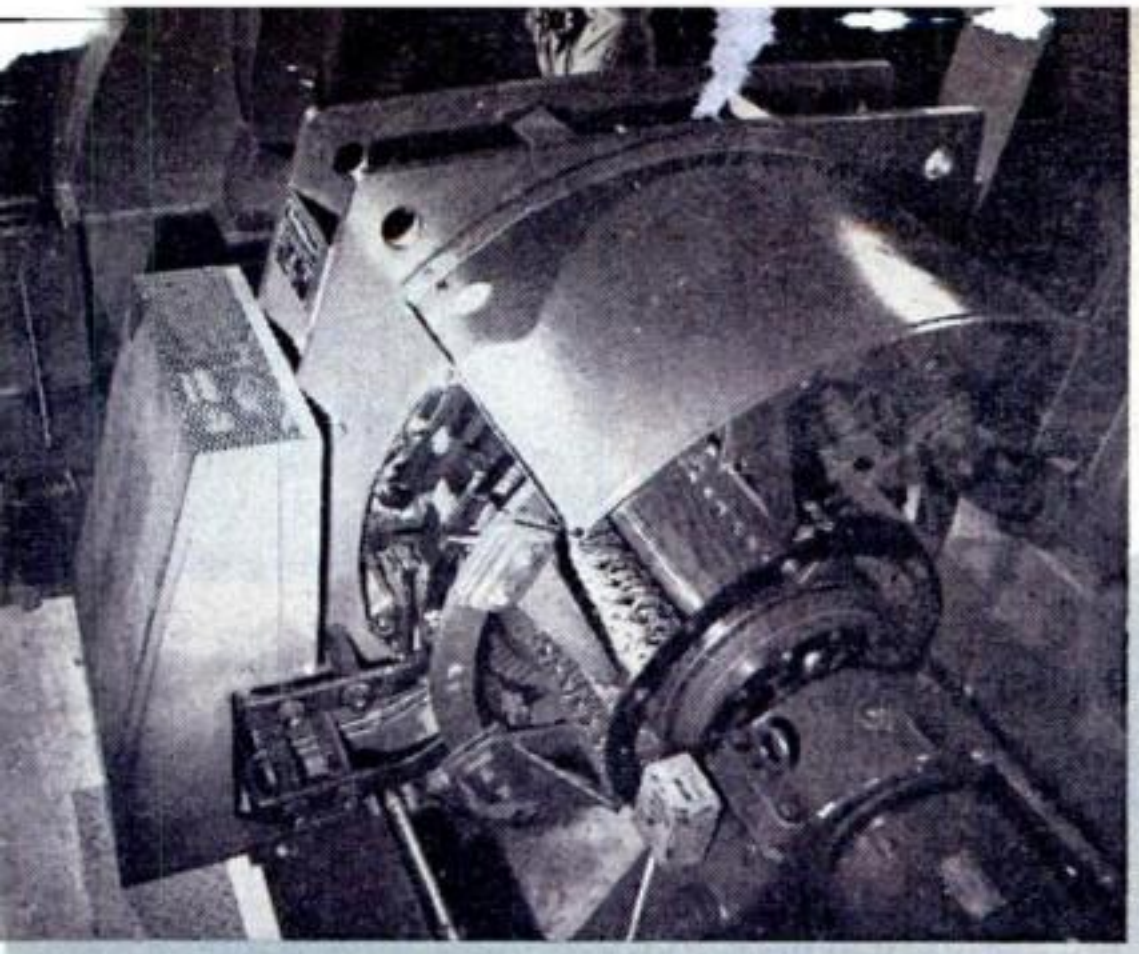
AC GENERATOR

Drawing by STEWART ROUSE

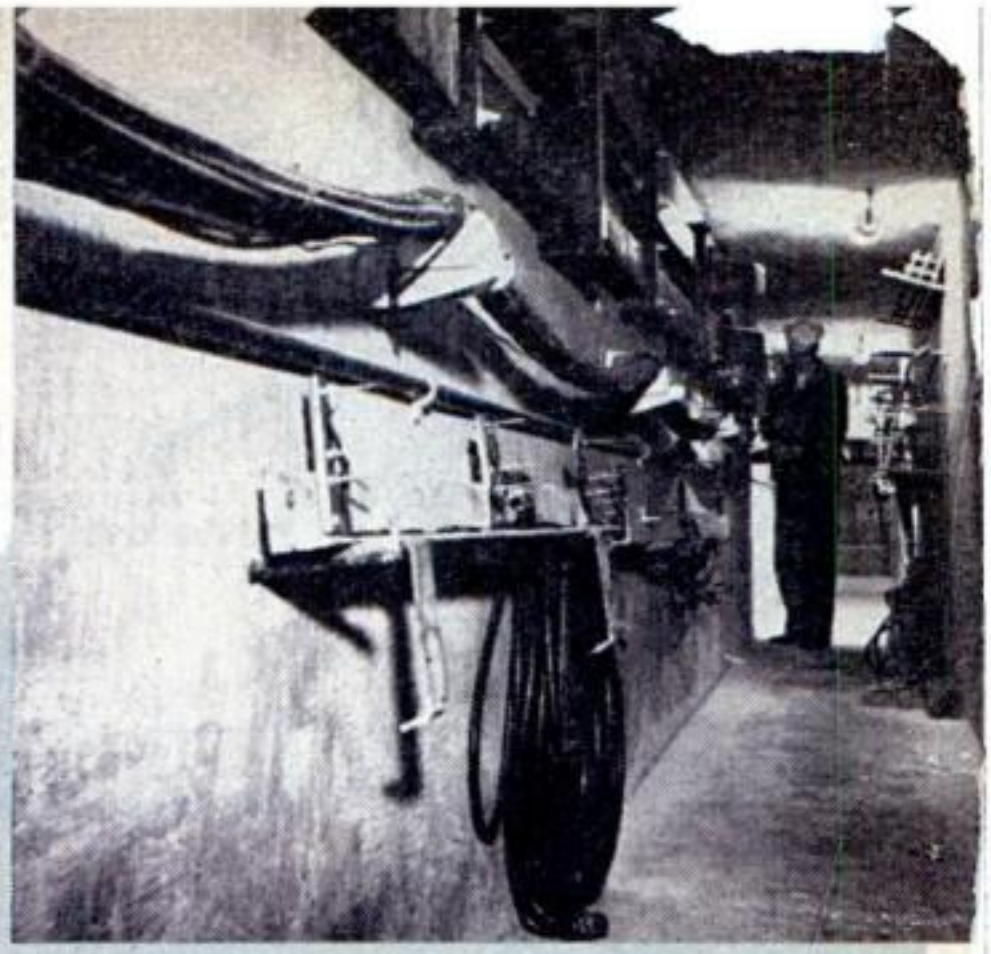
ENERGY STORED IN 24-TON FLYWHEEL DRIVES AC GENERATOR TO PRODUCE 12,000 KW. OF POWER NEEDED FOR TAKE-OFF RUN

This 1,100-hp. Pratt & Whitney aircraft engine is the original power source, driving the DC generator at the right. The propeller is only used to suck in the air that keeps the engine cool.

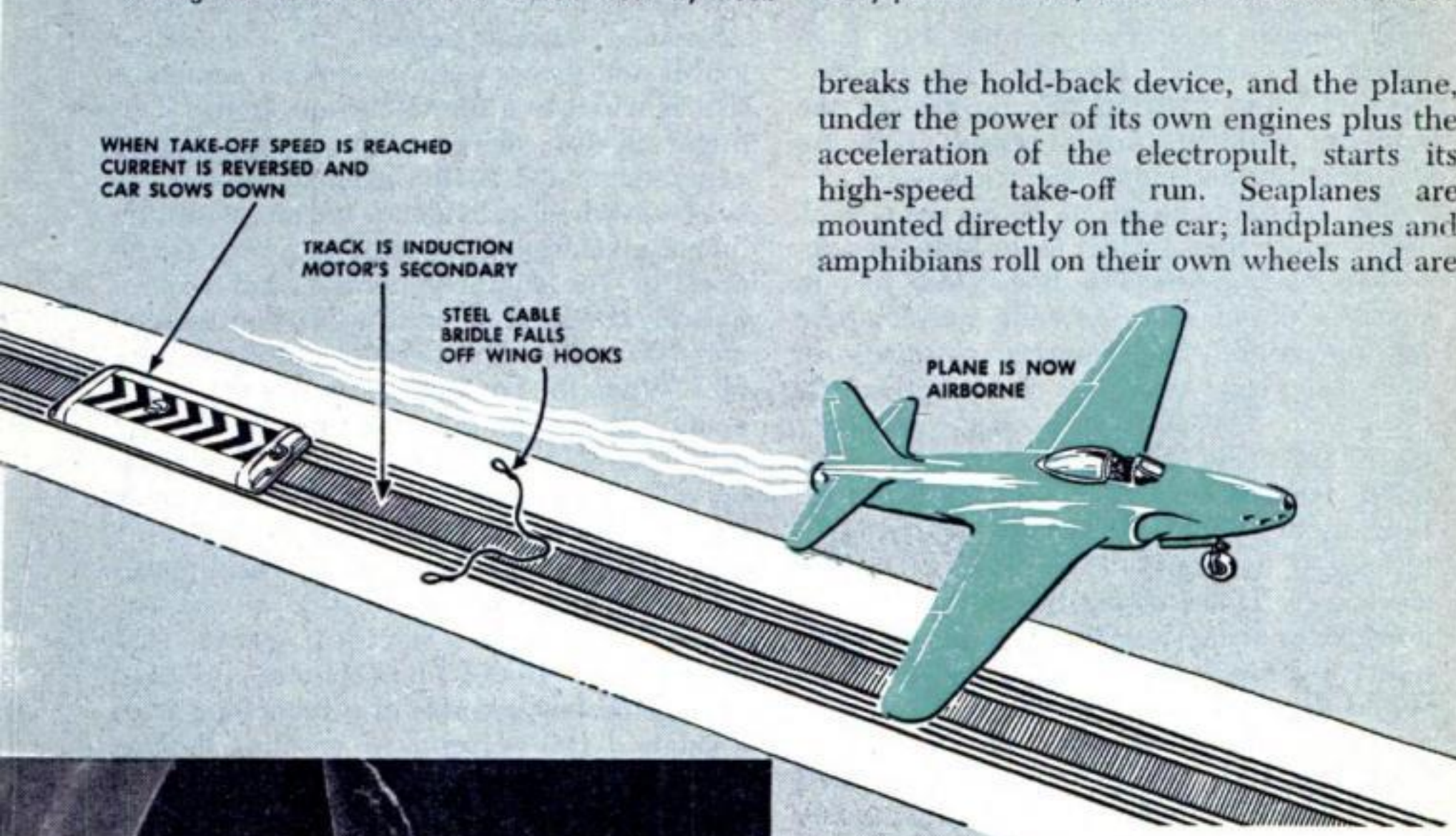
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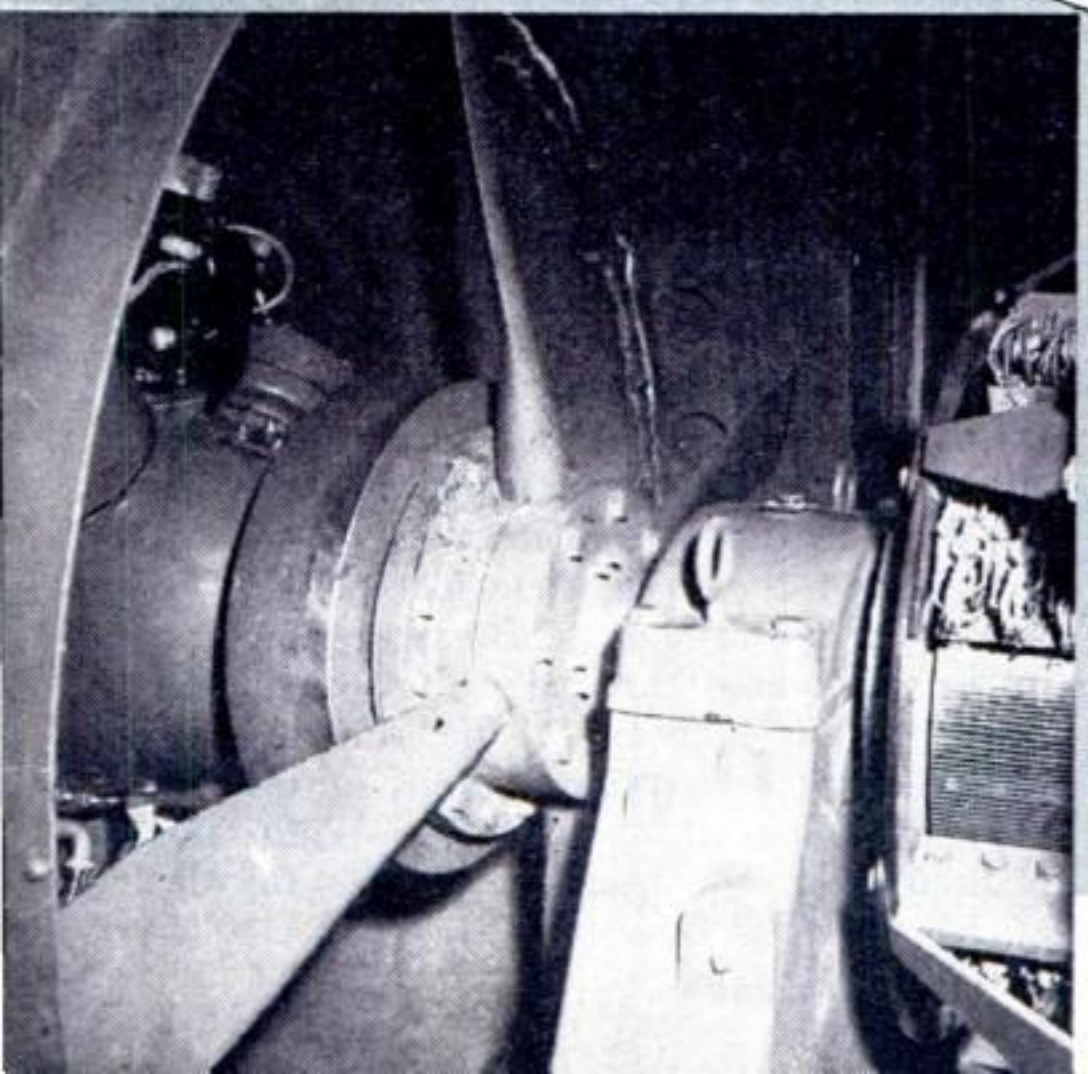
The DC motor, foreground, is linked to the huge AC generator in the background. Out of sight along the same shaft is a 24-ton steel flywheel.



This tunnel runs from the underground generator room to beneath the track. Bus bars along left wall carry power to track; below them are control cables.

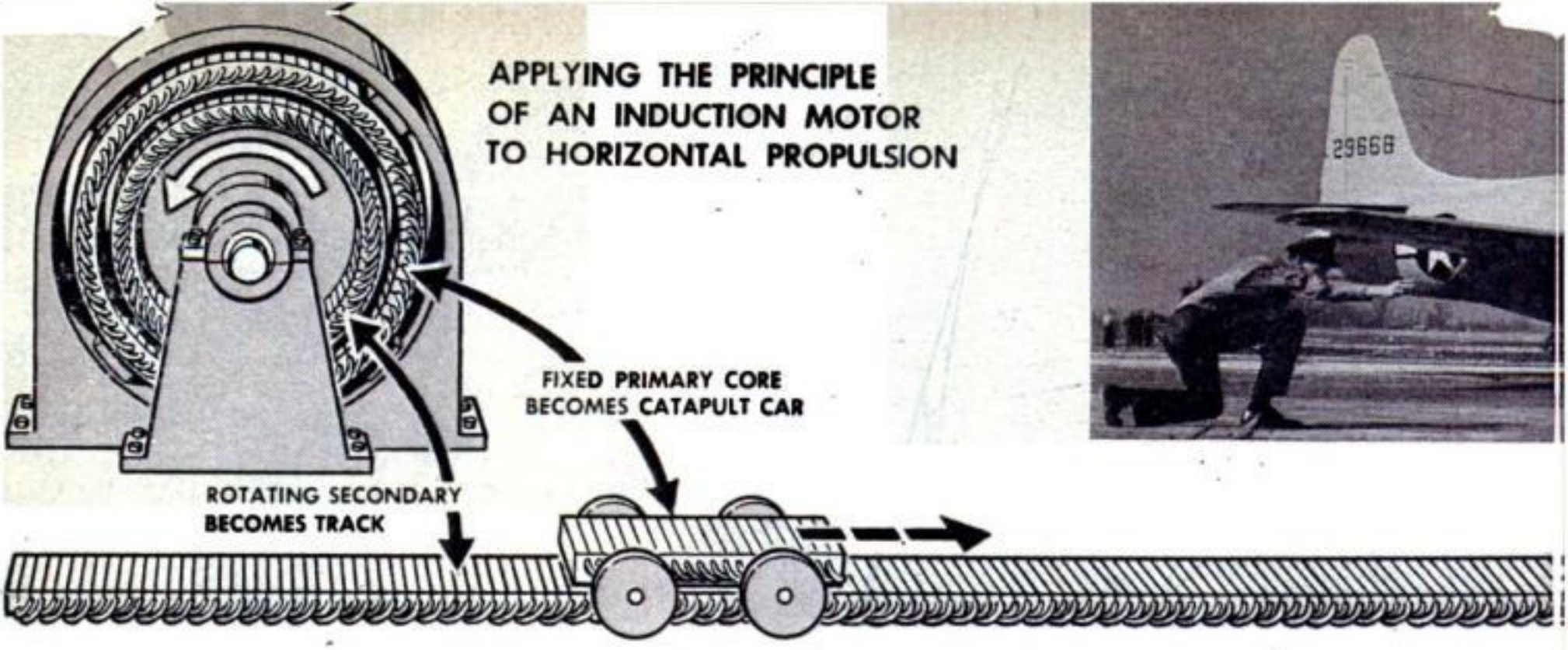


breaks the hold-back device, and the plane, under the power of its own engines plus the acceleration of the electropult, starts its high-speed take-off run. Seaplanes are mounted directly on the car; landplanes and amphibians roll on their own wheels and are towed by the car. When flying speed is reached, the launching car automatically slows down, the catapult bridle drops off, and the plane takes to the air.



Electrically, the electropult is a 440-foot-diameter induction motor turned inside out, opened up, and flattened out. The motor's secondary core and squirrel-cage windings form the flat 1,382-foot tracklike runway mounted in a concrete trench flush with the ground. The moving shuttle car contains the motor's primary core and windings. As in all induction motors, power fed into the car's primary windings induces a current in the track's core and windings and devel-

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ops the necessary electromotive force to drive the car forward.

The 12-by-3½-foot launching turtle rides on 18 wheels that roll on two sets of double rails (upper rails prevent the car from lifting) concealed beneath the runway. Contact shoes pick up the current for the primary windings from copper collector rails that are also under the runway.

The track, made up of 76 sections, each a little more than 18 feet long, is divided into two main parts. The first 1,000 feet of track is designed to provide acceleration. In this portion, the electrical resistance of the secondary windings is progressively decreased. This makes the car (primary) go progressively faster as it moves down the track. The remaining 382 feet, designed for slowing the car down after take-off, has high-resistance windings. The car is braked electrically by reversing the power connections to its primary windings. This develops a driving force in the opposite direction. When the car has slowed down, direct current fed to the windings brings it to a stop. The entire braking system is operated automatically by electric relays mounted at intervals along the track.

The designer of the electropult's track ran into mechanical as well as electrical problems. A metal structure 1,382 feet long is sensitive to the weather; it expands and contracts like the mercury in a thermometer. Such temperament was allowed for by anchoring the track only at its center, and permitting the ends to slide in or out on supporting beams. During the course of a normal day, the track expands and contracts as much as four inches at each end. Variations in the level of the track are compensated for by adjusting screw jacks under the supporting beams.

Because of the tremendous power needed during a launching, a unique underground power unit had to be devised. The chain of events is reminiscent of some of Rube Goldberg's ideas. A 1,100-horsepower radial, air-cooled aircraft engine is the prime mover and drives a direct-current generator that is wired to a direct-current motor. This motor, in turn, drives an alternating-current generator and a 24-ton steel flywheel. The heavy flywheel provides a means of storing potential energy. In operation, power developed by the engine-generator unit is used to bring the flywheel unit up to its full speed of 1,700 r.p.m. This takes about seven minutes. When the launching signal is given, the energy stored in the spinning flywheel is used to drive the alternating-current generator and supply the burst of electric power needed to send the launching car speeding down the track. Such a flywheel-power arrangement makes it possible to get the 12,000 kilowatts of electrical power (approximately 15,000 horsepower) needed during the few seconds of a launching from a single 1,100 horsepower gasoline engine.

Four skilled technicians are needed to put the electropult through its paces. Two men are located above ground to observe the launching and to operate emergency switches in case something goes wrong. One, the launching officer, is at the head of the runway and the second is stationed at the halfway mark. The other two are in the underground power station—one to operate the aircraft-engine controls and the other the switches for the electrical system. It is the man at the main electrical panel who actually throws the switch to send the plane on its way when he receives the signal from the launching officer at the runway. He also calculates the actual point of take-off for the airplane from its known weight and standard take-off speed, and sets up the

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Naval officer gives take-off signal. Run will be 320 feet instead of 2,000 feet usually needed.



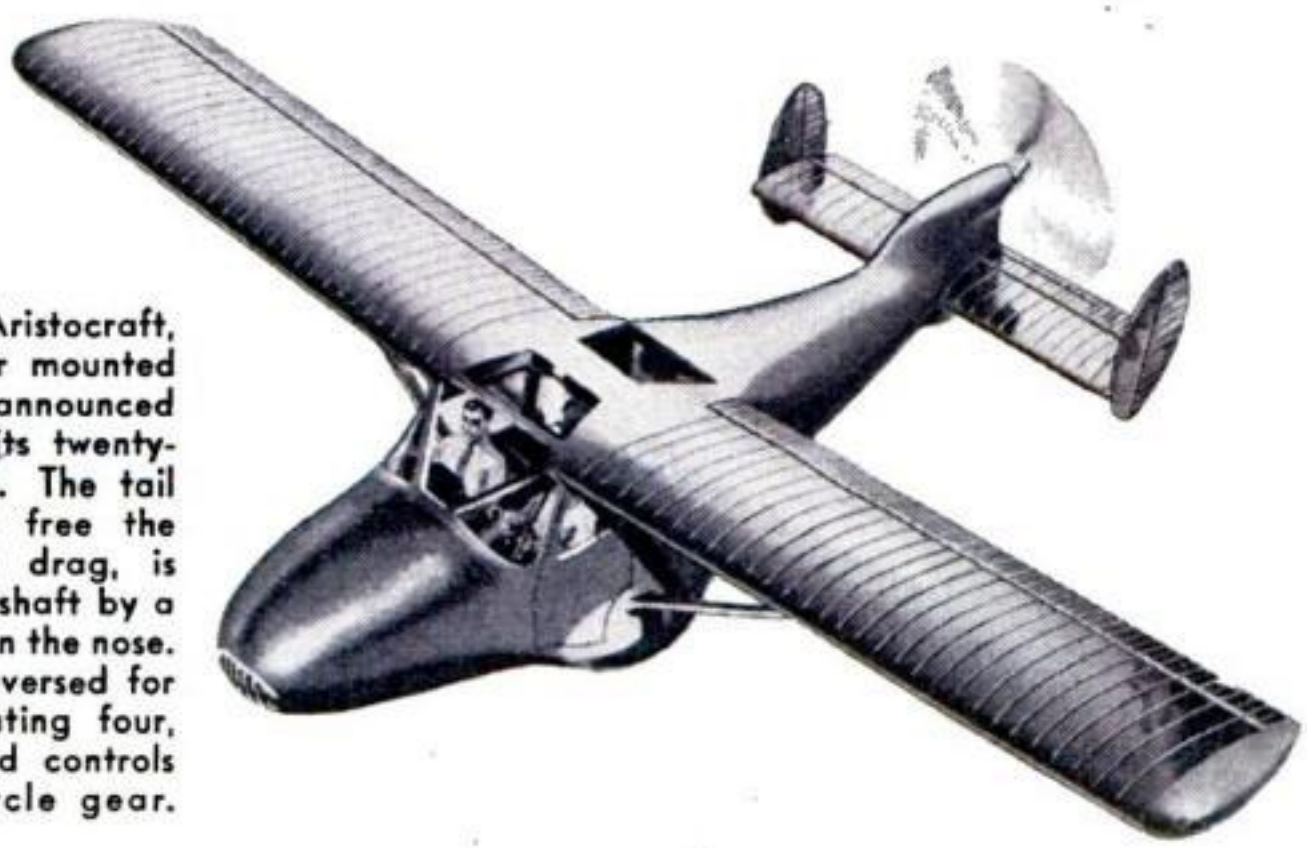
The bridle drops to the ground an instant before the P-80 jet fighter becomes airborne at 116 m.p.h.

electrical relay system for that particular take-off condition by adjusting a dial on a distance-selector drum. Once this has been done, the relays spaced along the track automatically reverse the power at the proper moment to slow the car down, free the plane, and then apply direct current to bring the car to a stop. However, if the automatic electrical system should by any chance fail, the car can be stopped with hand switches on the two above-ground control boxes along the runway.

The launching car does not jump when the main switch is thrown to feed the power to the electropult. Instead it waits for the power to be built up. This takes about one quarter of a second. The flat motor then develops enough force to break the hold-down unit and allow the car and plane to start the take-off run. Hence, no great starting jerk is felt by pilot or passengers.

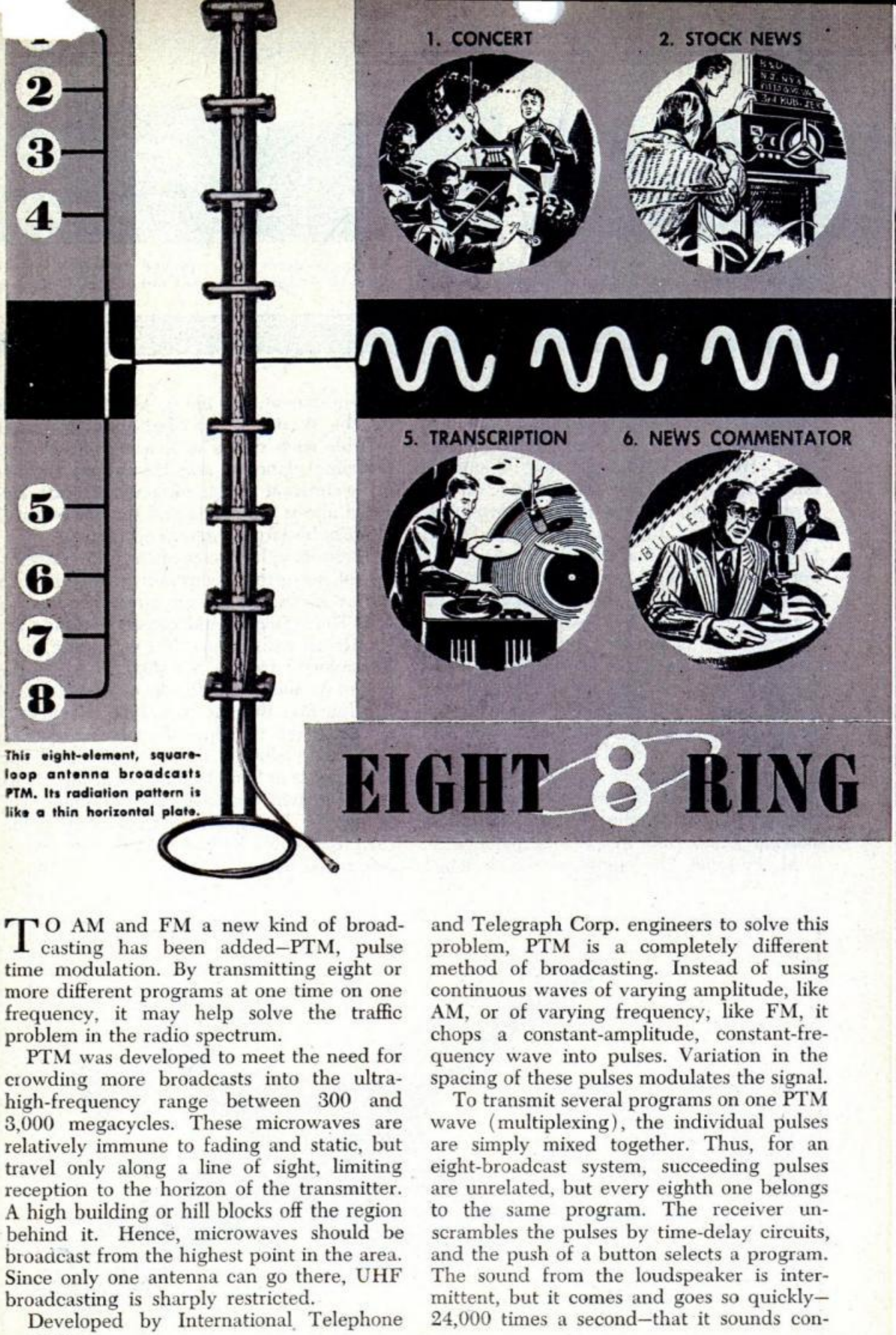
M. F. Jones, the engineer who designed the equipment, sees many future possibilities for the Westinghouse electropult. It makes feasible such things as floating airports for refueling planes at sea; barge-type airports for waterfront cities; mid-city airports elevated above buildings; and the use of small airports by large, high-speed planes.

Right now, he is considering the possibilities of using the electropult in reverse as a means of shortening an airplane's landing run. The system would consist of fitting the shuttle car with an arresting cable that could be engaged by the arresting hook on the plane. As the plane flies in over the end of the runway, the car would be accelerated to match the speed of the plane and then electrically slowed down after hook and arresting gear had become engaged. With such a system, landings could be made well within the length of the track. Any plane, then, that could be launched by the electropult could be landed by it.



The unconventional Aristocraft, with a pusher propeller mounted on the tail, has been announced by Waco Aircraft as its twenty-fifth anniversary model. The tail propeller, designed to free the plane from slipstream drag, is driven via an extended shaft by a 215-hp. Franklin engine in the nose. The propeller can be reversed for ground operation. Seating four, the plane has simplified controls and retractable tricycle gear.

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This eight-element, square-loop antenna broadcasts PTM. Its radiation pattern is like a thin horizontal plate.

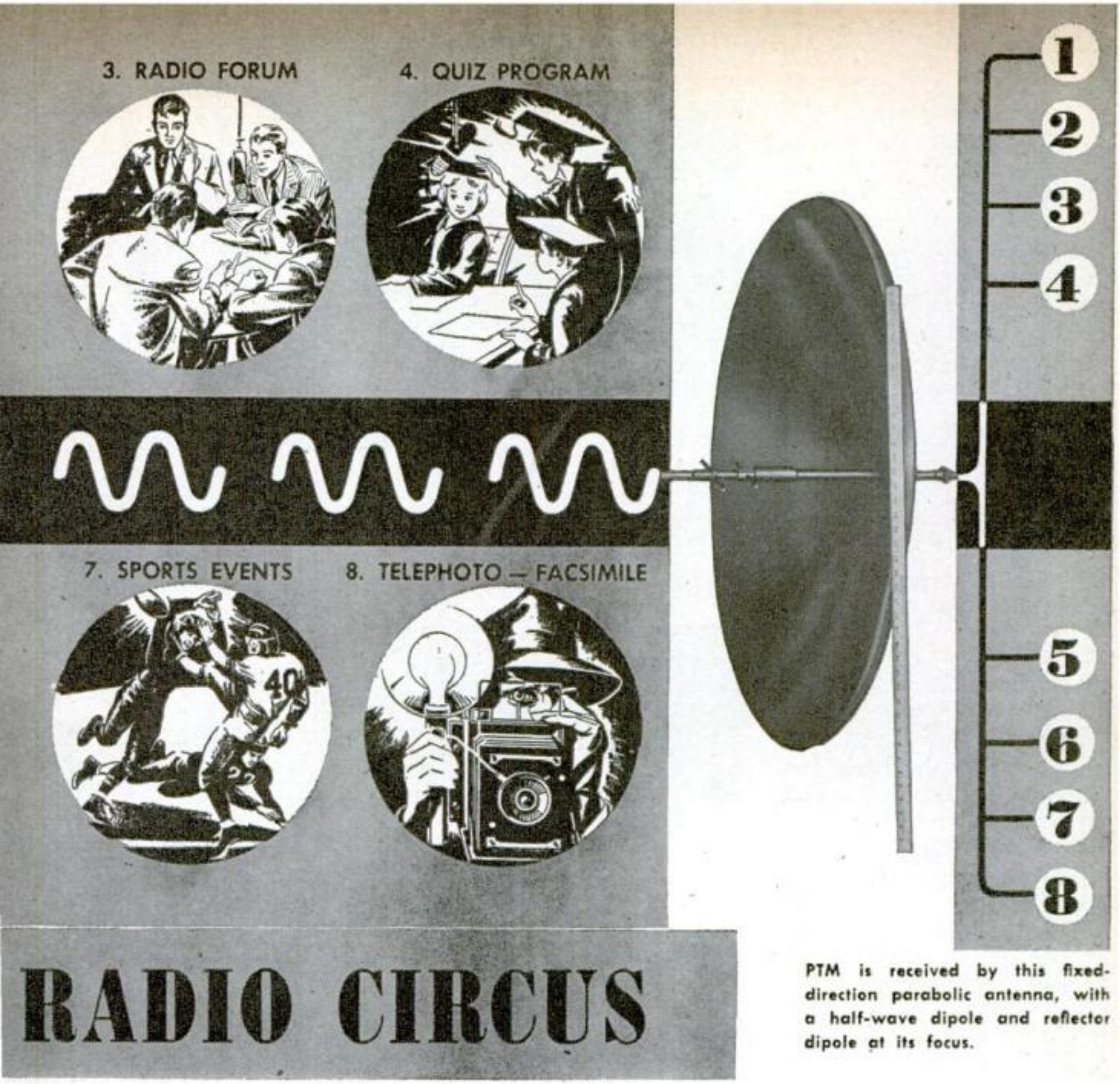
TO AM and FM a new kind of broadcasting has been added—PTM, pulse time modulation. By transmitting eight or more different programs at one time on one frequency, it may help solve the traffic problem in the radio spectrum.

PTM was developed to meet the need for crowding more broadcasts into the ultra-high-frequency range between 300 and 3,000 megacycles. These microwaves are relatively immune to fading and static, but travel only along a line of sight, limiting reception to the horizon of the transmitter. A high building or hill blocks off the region behind it. Hence, microwaves should be broadcast from the highest point in the area. Since only one antenna can go there, UHF broadcasting is sharply restricted.

Developed by International Telephone and Telegraph Corp. engineers to solve this problem, PTM is a completely different method of broadcasting. Instead of using continuous waves of varying amplitude, like AM, or of varying frequency, like FM, it chops a constant-amplitude, constant-frequency wave into pulses. Variation in the spacing of these pulses modulates the signal.

To transmit several programs on one PTM wave (multiplexing), the individual pulses are simply mixed together. Thus, for an eight-broadcast system, succeeding pulses are unrelated, but every eighth one belongs to the same program. The receiver unscrambles the pulses by time-delay circuits, and the push of a button selects a program. The sound from the loudspeaker is intermittent, but it comes and goes so quickly—24,000 times a second—that it sounds con-

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PTM is received by this fixed-direction parabolic antenna, with a half-wave dipole and reflector dipole at its focus.

RADIO CIRCUS

tinuous, just as interrupted images on a movie screen look continuous.

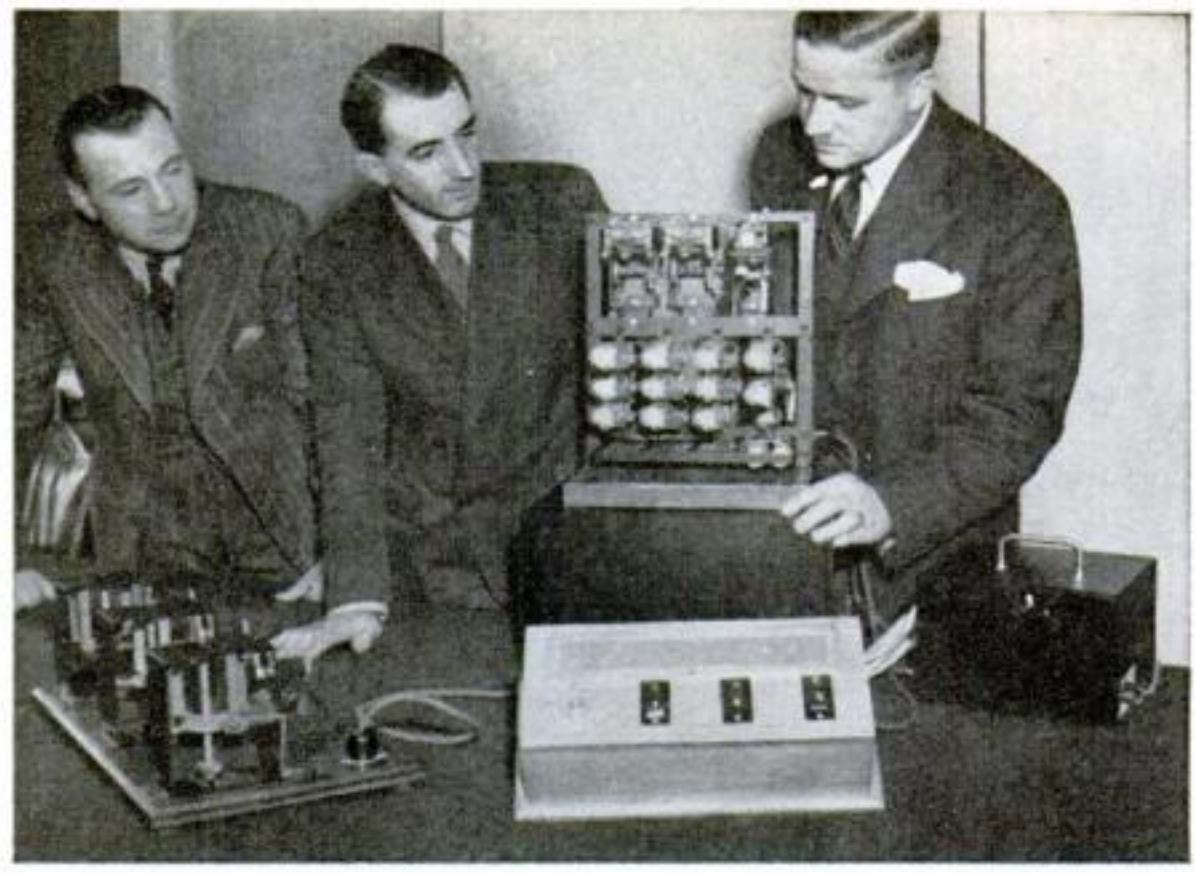
An experimental PTM station in New York City broadcasts on 930 megacycles, using a stacked, square-loop antenna. This radiates horizontal, pancakelike beams that lose little power to the sky. As many as 16 high-fidelity broadcasts are possible, and several hundred radiotelegraph messages can be handled at once.

Since PTM uses its own unique modulation system, listeners need special receivers. PTM sets have two main advantages: fixed frequency, needing no complicated tuning devices, and a directional, high-gain antenna permanently aimed at the single sending station. Tonal quality and cost of the sets are about the same as those of a high-quality AM or FM receiver.

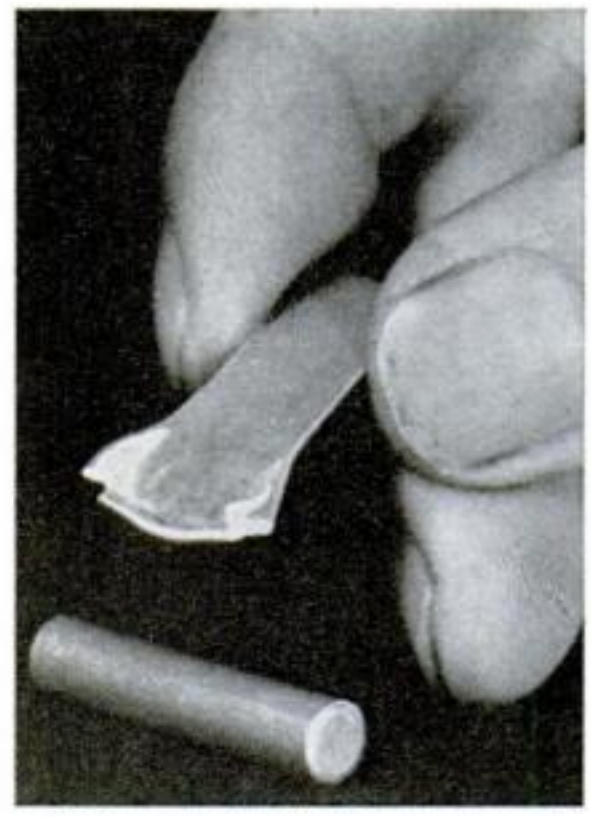
Eventually, if crowding of the air waves continues to increase, eight entertainment programs may be broadcast by one PTM station. For the present, however, the difficulty of replacing millions of home radios makes such a use of PTM unlikely. Many other applications are likely to come sooner. The Signal Corps, for which PTM was originally developed, uses it in field communications (PSM, January, '46, p. 188). Cities could make all municipal broadcasts from one PTM station. Firms that telephone recorded music to restaurants could use a single PTM station to offer eight choices. Business and market news might go out over PTM, and press associations could use it for teletype and radiophoto services. All these varied types of transmission have been successfully demonstrated.

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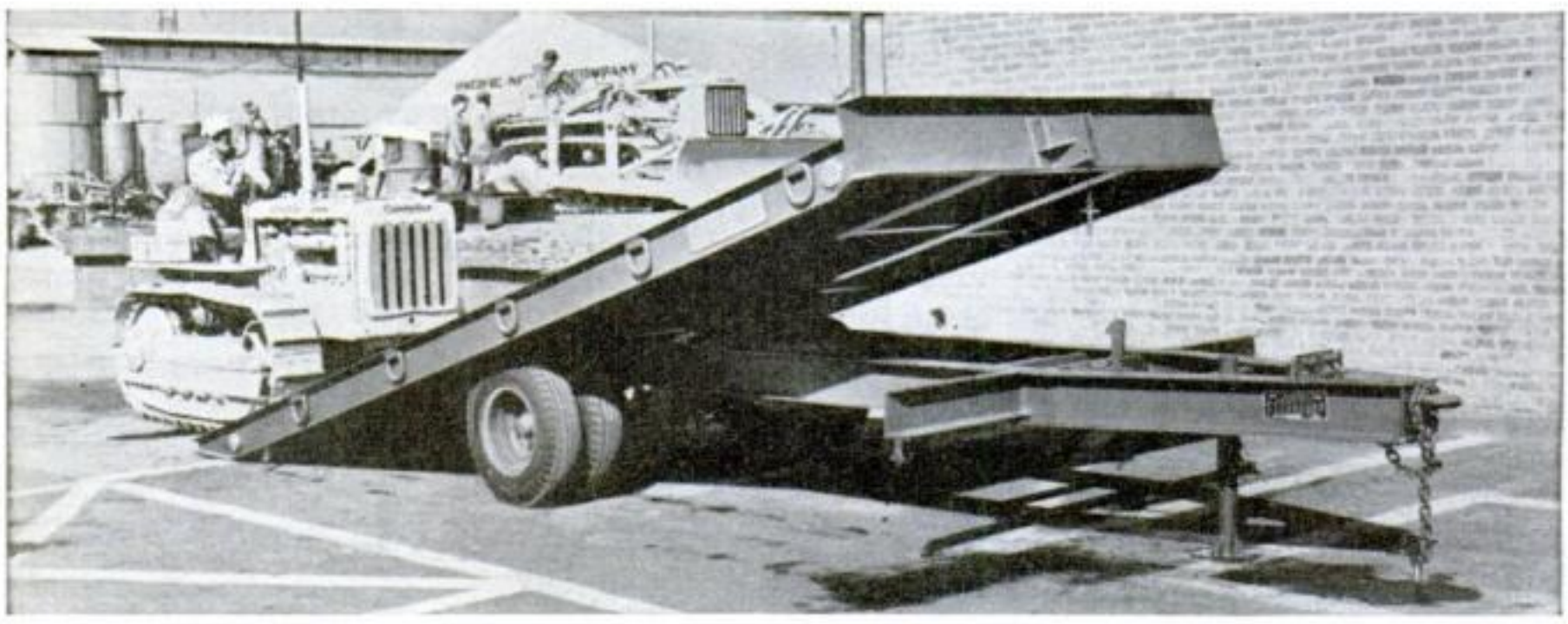
Crowd Counter. Devised in Britain to prevent the overcrowding of sports arenas, an automatic gate checker will count entries wherever turnstiles are used. When capacity is reached, the counter rings an alarm bell. The model in the photo includes (left to right) miniature turnstiles, control and indicator panel with counting unit behind it, and the power supply unit. In its original form, the device handles up to 33 turnstiles, showing at all times the exact admission total.



RDX at Work. Too powerful for direct use in blasting, the war-tried explosive RDX has been put to work in the "Big Inch" dynamite detonating cap. The caps, 1⅛ inches long, are not sensitive to impact, as is indicated by the two shown; a 10-pound weight squashed the damaged one without setting it off. At far right, a technician examines fused dynamite with a cap buried in it.







Tilting Trailer. Eliminating the need for hoisting tractors and other slow-moving machines aboard for long hauls, the bed of this low-deck trailer tilts down to let the load come aboard under its own power. When the load passes the midpoint of the trailer, its weight forces the bed to a horizontal position, and a metal catch holds the bed firmly in place. It is made by the Fruehauf Trailer Co., of Los Angeles.

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FLYING on the ground

Constitution spent 1,000 hours "aloft" as a mockup before it first flew.



BEFORE the 92-ton Lockheed Constitution (PSM, Oct. '46, p. 75) first took to the air it had "flown" 1,000 hours—in a second-floor laboratory at Burbank, Calif.

Time and again a mockup of the monster craft was put through every conceivable flying maneuver under all possible simulated conditions of weather and altitude. Each working part and instrument was tested and checked, retested and rechecked. And when, after three years of assembly and experimentation, the Navy's XR60 was finally poised for its sky debut, its engineers had a fairly reliable picture of how it would behave in actual flight.

In the last two years, the earth-bound Constitution "took off" and "landed" 5,000 times. Its controlling hydraulic mechanisms, with their 25 miles of lines, 115 pumps and 151 AC motors, ran through 500,000 cycles. The XR60's brakes underwent tests at temperatures from -65 to 165 degrees F. in approximating conditions from polar to tropical. Its locks were packed in dry ice to determine whether they would open and close instantly under the most adverse conditions. Then they were shot through with mud and dust and sent through the same paces.

The tubing, fittings and other integral parts of the transport's vital one-shot lubricating system would be subjected to an internal pressure of 3,000 pounds in normal flight. In the laboratory's bursting chamber, however, they were given 12,000-pound jolts of pressure. For double assurance, the system as a unit was put through many 4,500-pound pressure tests.

The fueling layout, too, was taken over all the jumps before it was installed in the XR60. Quantities of gasoline at various pressures were forced through the same number of bends, climbs and drops as are found in the prototype's gasoline lines. On the Constitution, gas can be pumped from any tank to any engine, but pressure at the carburetors must always remain constant. Such pressures could only be obtained safely by countless trials on the mockup.

Four independent electrical circuits supply the multitude of motors operating the Constitution's hydraulic system. If a circuit fails, another automatically picks up the load. These life lines had to be tried and retried.

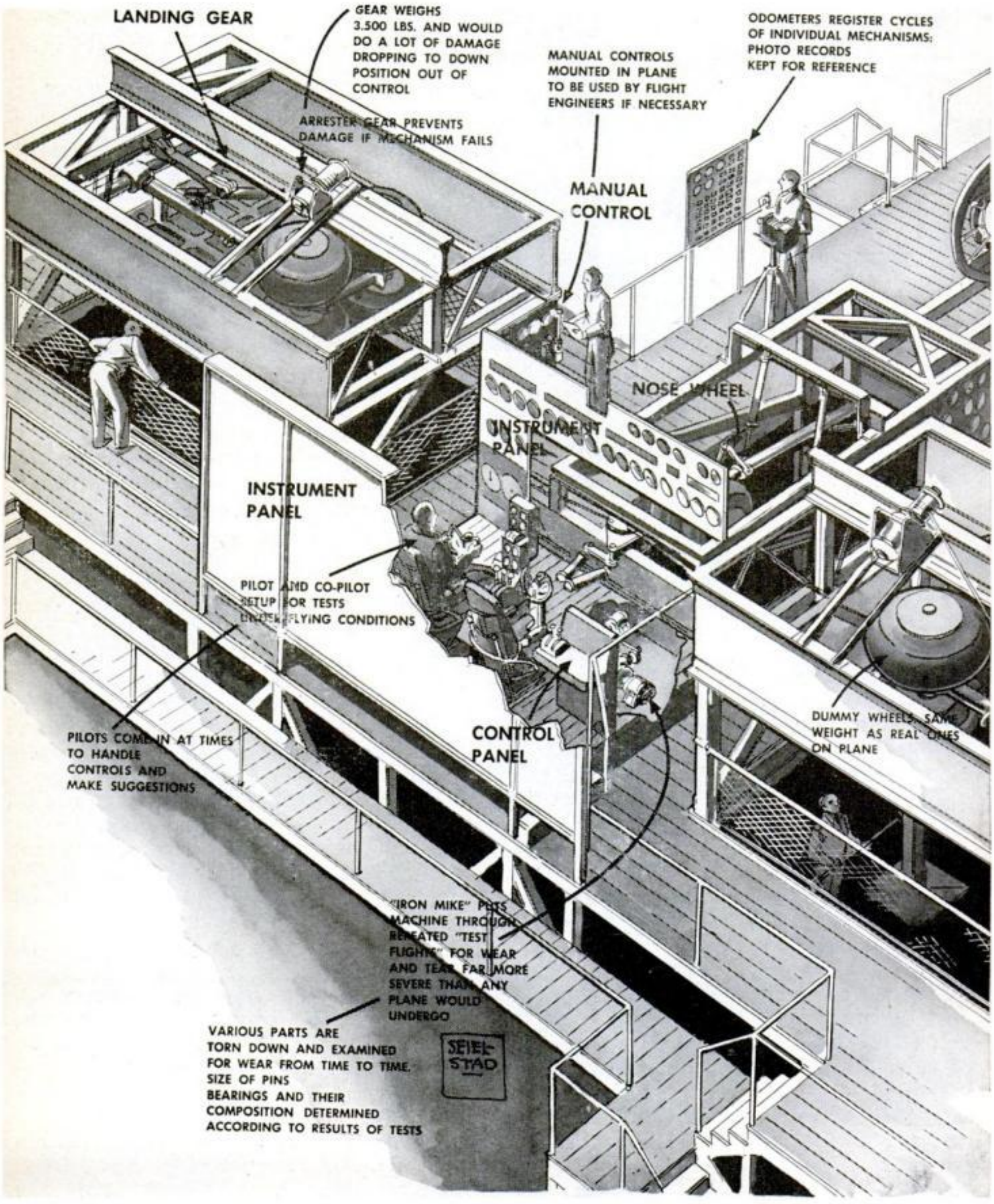
The craft's hydraulic and electrical systems have as many as three sets of alternate controls to take over in case one goes out. The 10-wheeled landing gear, for example, can be let down hydraulically, electrically or manually. Three separate hydraulic systems are available for operating the elevators, two for the rudder and two for the ailerons. All these had to pass rigid inspection in the laboratory runs.

When they operated the mockup on its

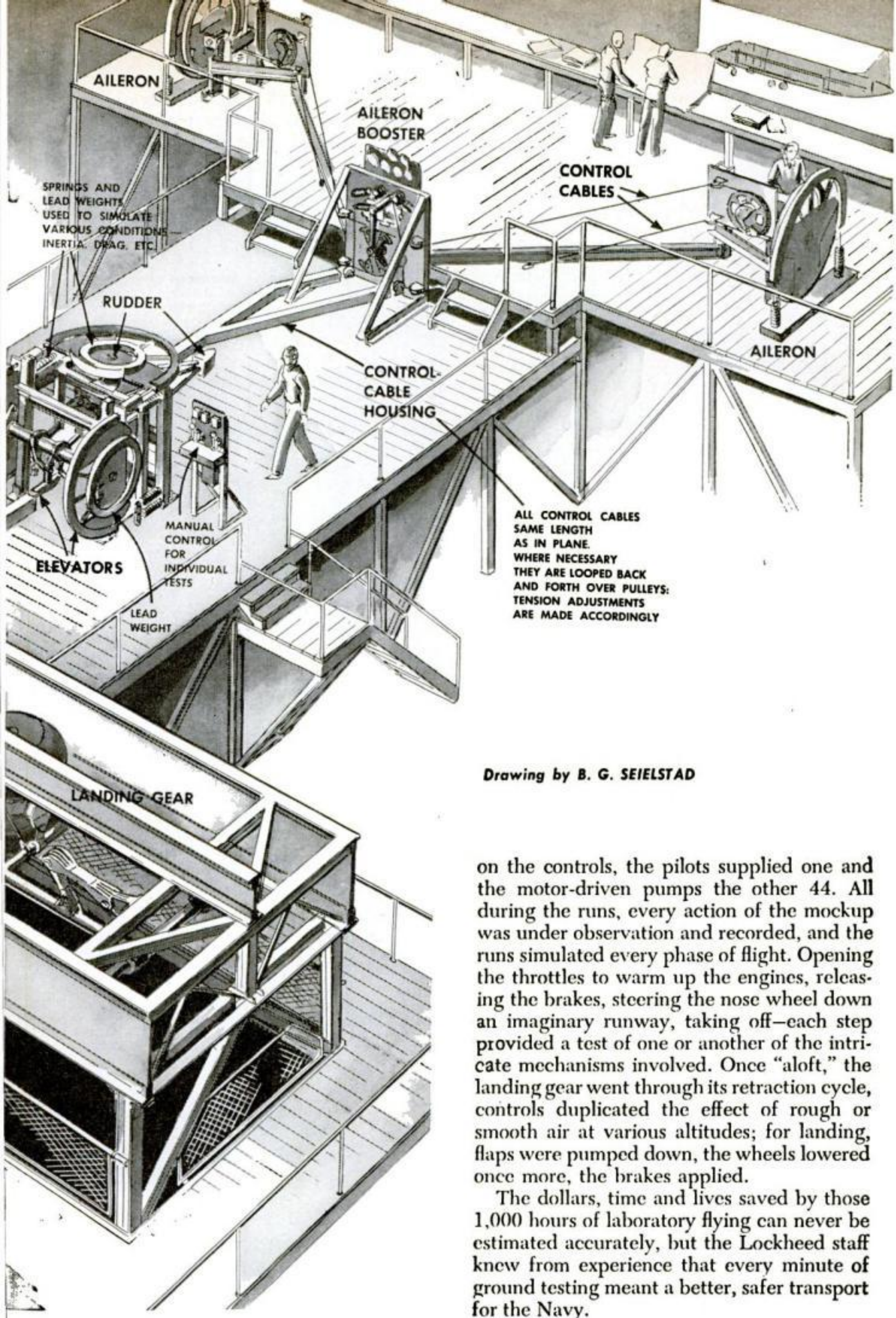
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35-minute laboratory runs, the pilot and co-pilot were surrounded by instrument panels identical with those in the Constitution's operating cabin. To save laboratory space, however, this compartment faced the rear of the model and the pilots looked out on the landing gear, ailerons, rudder, elevators and the various hydraulic and electrical mechanisms shown in the accompanying illustration.

For each 45 pounds of pressure needed



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Drawing by B. G. SEIELSTAD

on the controls, the pilots supplied one and the motor-driven pumps the other 44. All during the runs, every action of the mockup was under observation and recorded, and the runs simulated every phase of flight. Opening the throttles to warm up the engines, releasing the brakes, steering the nose wheel down an imaginary runway, taking off—each step provided a test of one or another of the intricate mechanisms involved. Once "aloft," the landing gear went through its retraction cycle, controls duplicated the effect of rough or smooth air at various altitudes; for landing, flaps were pumped down, the wheels lowered once more, the brakes applied.

The dollars, time and lives saved by those 1,000 hours of laboratory flying can never be estimated accurately, but the Lockheed staff knew from experience that every minute of ground testing meant a better, safer transport for the Navy.

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By WILLIAM P. VOGEL, JR.

FOR three years, the world's most powerful atom-smasher has been secretly but noisily at work. It is known as the betatron, and its chief job is to help physicists find out what makes the atomic nucleus tick. The betatron pours out an intense beam of very short X-rays, 20,000 times more powerful than those used to photograph a broken bone.

Even though the betatron produces X-rays rated at 100,000,000 electron volts, the scientists are not satisfied. Before long they will have rebuilt the machine to increase its output energy to at least 160,000,000 electron volts.

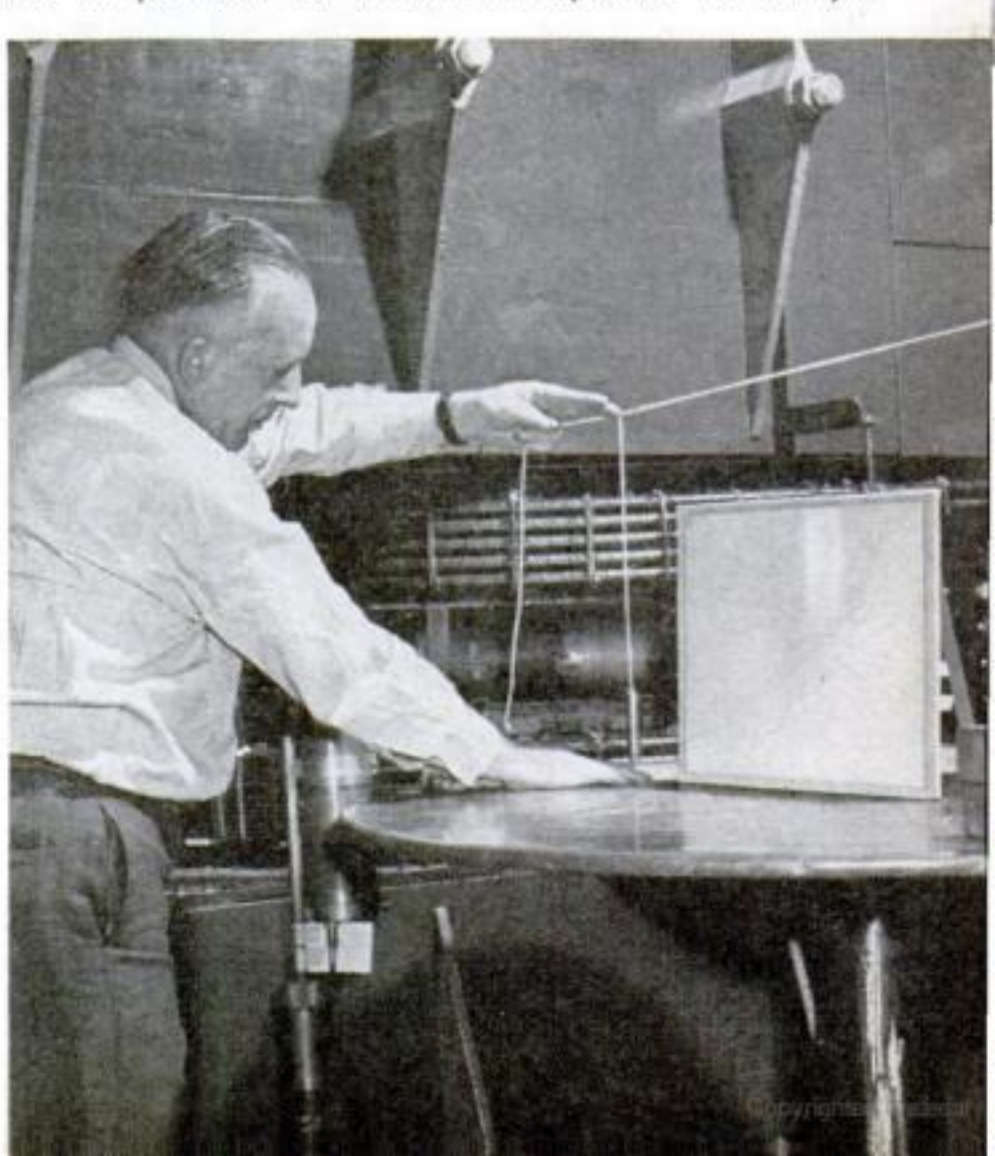
Compared with the volts and amperes you need to light your house, 160,000,000 electron volts isn't very much energy. But the electrons creating the betatron's X-rays are so minute, and so many of them are used each microsecond, that the total energy, on the atomic scale, is such as has been found hitherto only in the spontaneous fission of atomic nuclei and in cosmic rays from interstellar space. When the betatron's electrons produce X-rays, their mass, according to the relativity theory, has increased 200 times, and their speed is 99.998 percent that of light.

The betatron is one of the most important laboratory devices adding to our knowledge of what happens when an atomic nucleus bursts apart. The Manhattan Project has ordered a betatron to supplement its researches with chain-reaction piles. Ultimately the betatron and other devices like it will help scientists answer the question as to whether atomic energy can be converted to steady production of power.

The betatron shown on these pages was built by General Electric research scientists. It creates its X-ray beam by employing the principle of the ordinary transformer. One hundred amperes of alternating current at 24,000 volts flows through the coil of a 125-ton laminated silicon-steel magnet, inducing a powerful current in the betatron's secondary. The secondary, however, is not a coil as in a transformer, but a doughnut-shaped vacuum tube. Electrons, shot into the doughnut from an electron gun, are whirled around by the magnetic field. This



To take the picture above, a screen was set on a lead-topped table about 60 inches from the betatron target. Engineer used plumb bob to be sure screen was in position for maximum exposure to X-rays.

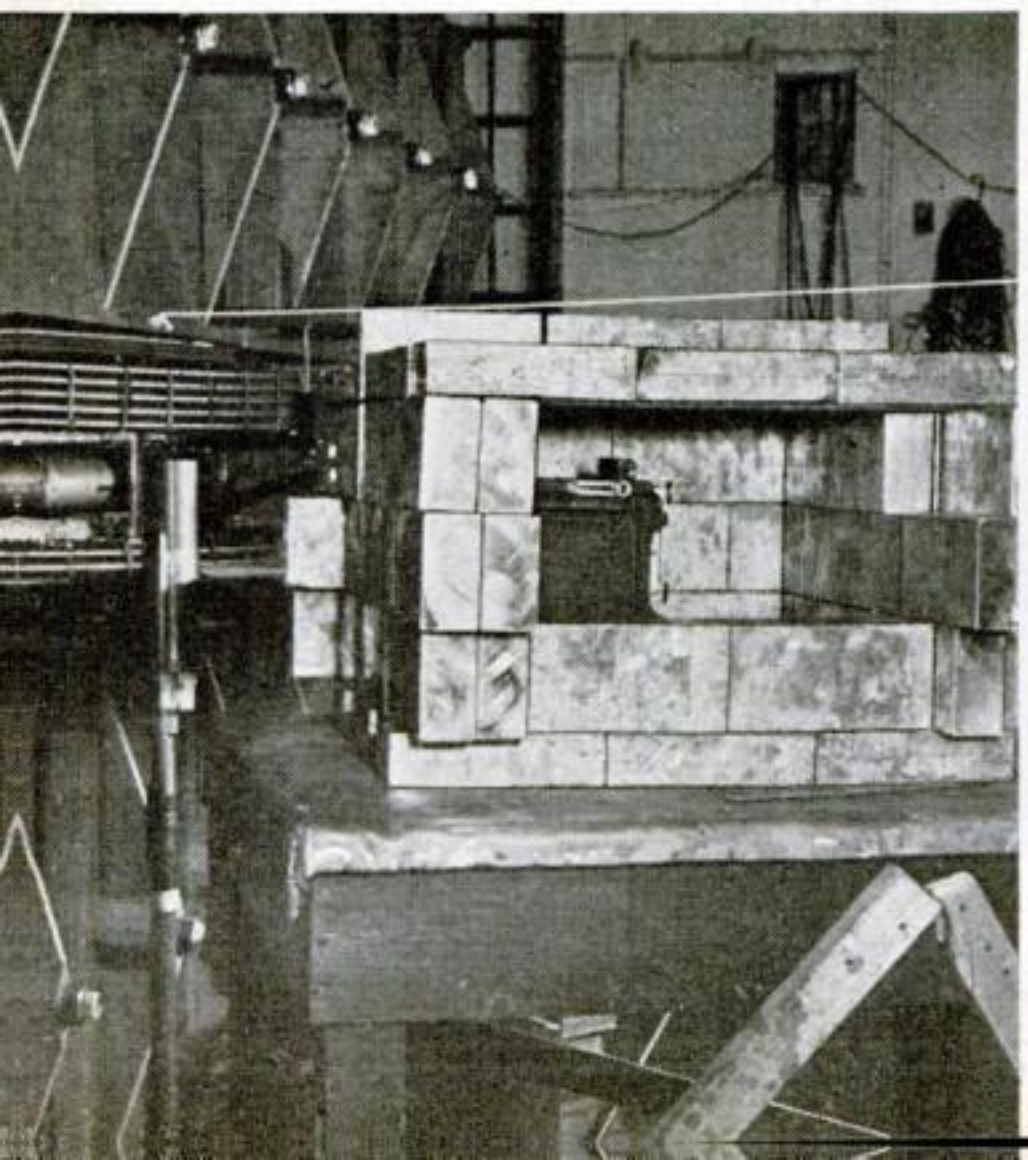


Electrons pitched by betatron
approach speed of light — and it's becoming mightier yet.

Science's BOB FELLER

First photograph ever made of the 100,000,000-electron-volt X-ray beam produced by G.E.'s betatron, taken by PSM photographers. Light for picture was created by impact of X-rays on fluorescent screen, plus secondary emission of electrons which penetrated screen from quarter-inch lead backing.

The PSM camera in its housing of 24-pound lead blocks. It took several men most of a day to set up camera. The lead-topped table and shielding weighed about a ton. Betatron is in left background.



Dial at far left showed 100,000,000 electron volts as photographers and scientists waited out 30-minute exposure. Beam brightness was unknown, requiring five test exposures. Lens opening was f/6.3.



concentrates them into a tight orbit and speeds them up with a push equivalent to 400 electron volts each time around. During the first quarter-cycle of a 60-cycle current flow, the electrons circle the doughnut approximately 250,000 times, travel about 800 miles in 1/240 second, and are speeded up to energies of 100,000,000 electron volts.

To put the electrons to work at maximum energy, the betatron then deflects them about 1½ inches, so that they strike a metal target with such force that its atoms are greatly disturbed. As the target atoms struggle to regain stability, they emit large quantities of intense X-radiation, at least 20 times stronger than the penetrating gamma rays given off by radium.

Speed Brings Concentration

Because of the great speed of the electron stream, X-rays from the betatron do not spread through space the way low-voltage X-rays do. Instead, they are concentrated into a narrow beam, measuring only two degrees of arc at the target. The X-ray beam always leaves the betatron at a known position, and can be intercepted by recording devices. The beam at the target is 15,000 times as strong as the maximum daily dosage of X-rays that human beings can stand, and no one can safely stay in the room when the machine is operating.

The betatron has been in the works since the 1930s. The 100,000,000-volt machine was designed and built under the direction of Dr. Ernest E. Charlton, head of the X-ray section of the G. E. Research Laboratory, and his associate, W. F. Westendorp (PSM, Dec. '42, p. 58), in 1943, but all work on nuclear physics was then under military wraps, and even the existence of the betatron was concealed.

Cosmic-Ray Substitute

But the betatron worked out well. The scientists were able to control their experiments at will. They could shoot the betatron's beam into a recording device when they were ready to take a photograph. No longer did they have to wait for the chance passage of a cosmic ray.

The device most often used in nuclear work was the Wilson cloud chamber, which contains nothing but air and water vapor. Atomic disintegrations occurring in the chamber, under the shock of the betatron's X-rays, create ions. The water vapor condenses into droplets on the ions, leaving tracks that can be photographed, measured and interpreted. A powerful magnetic field deflects negative particles one way and positive particles the other.

Now scientists want a machine capable of producing a billion volts in the laboratory. But the betatron, as originally designed, can never practically go to such energy levels.

"It is a question both of operation and of economics," Dr. Charlton told PSM. "Even with the 100,000,000-volt machine it is difficult to keep the electron stream from losing some of its energy by radiation. And as we go higher in voltage, we run into tremendous expense as well."

A betatron capable of 10,000,000-volt output, he explained, requires a magnet weighing a ton and needs a case measuring 38 x 14 x 22 inches. At 100,000,000 volts the betatron must have a 125-ton magnet and measure 180 x 76 x 108 inches. In a half-billion-volt betatron, the magnet alone would weigh 4,000 tons—about as much as 80 fully loaded boxcars.

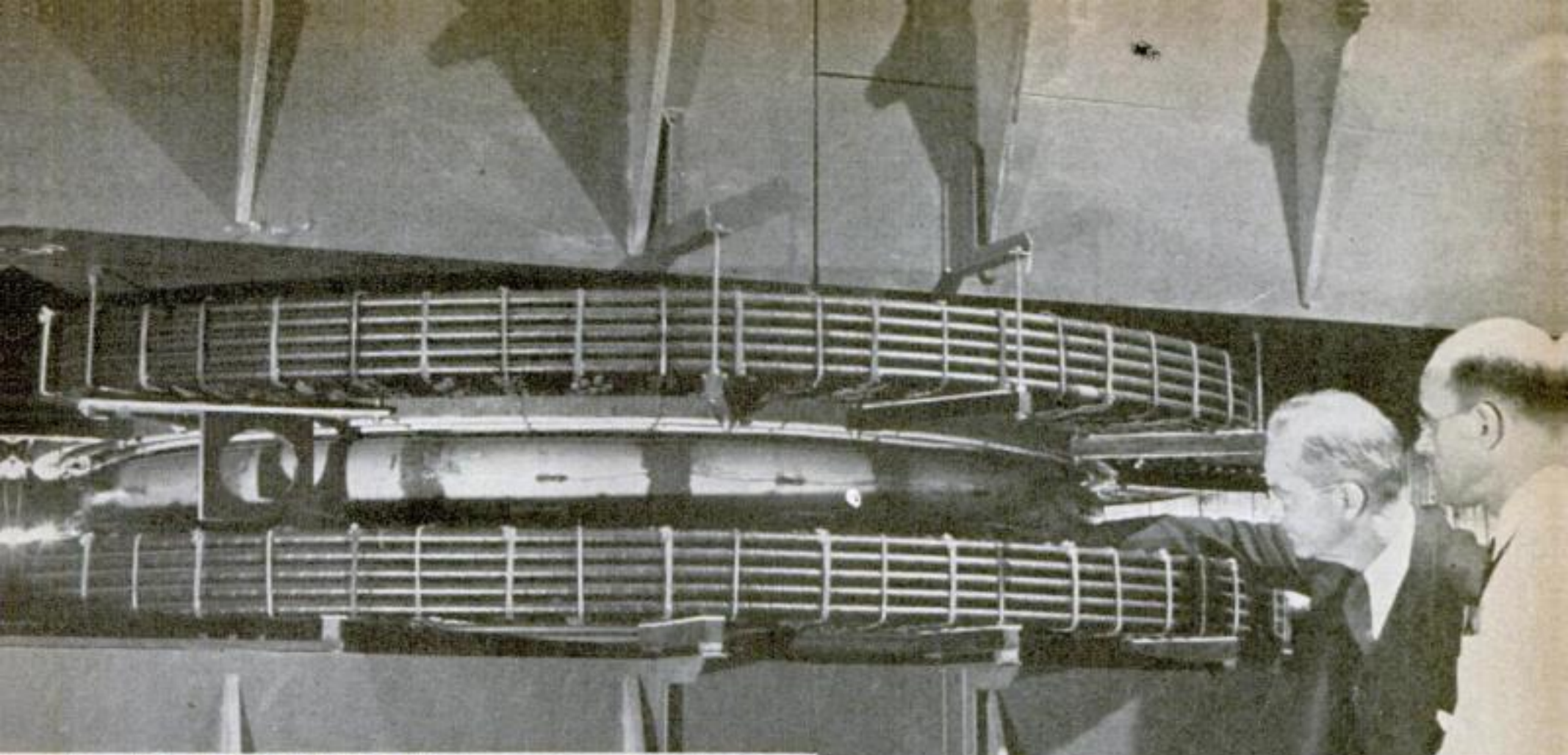
Putting Bias to Work

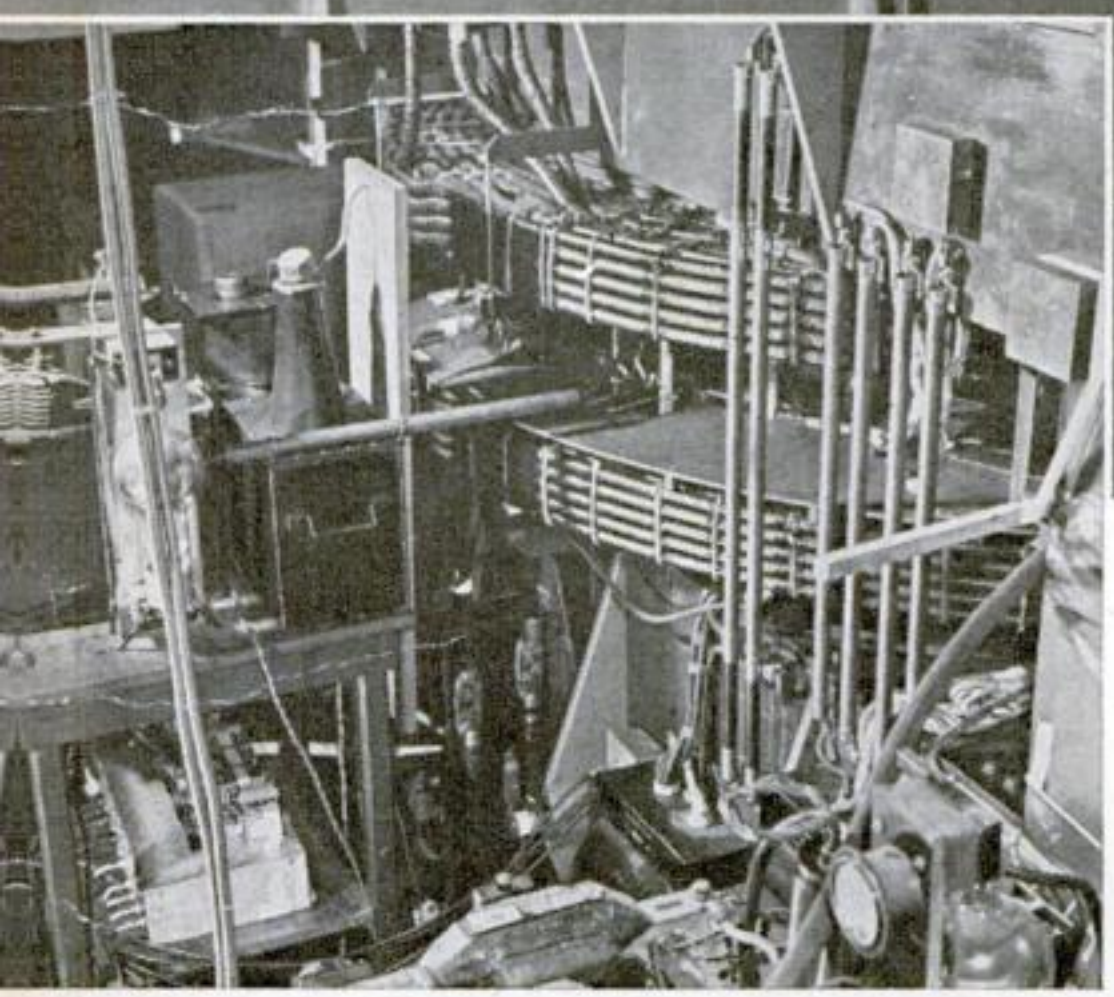
Westendorp, however, had thought of a way to reduce the weight. Why not put some direct current into the magnetic coil, to bias it the same way that a little direct current biases the grid of an ordinary radio tube? This would shift the zero line of the alternating current from the middle of the current wave to the bottom, so that almost the whole current cycle would speed up electrons, instead of just the first quarter-cycle. Thus higher output voltage could be obtained with a magnet of approximately the same size.

G. E. has backed Westendorp's idea and the necessary coils and related equipment are on order. Soon the 100,000,000-volt betatron will halt operations for rebuilding. Some time next year it will be ready to produce the most powerful radiation ever made by man.

One of the first big studies ahead of the biased betatron will concern the strange particles that seem to arise from the peculiar forces inside atomic nuclei. One class of these particles is known as mesotrons or mesons. Physicists believe mesons are heavy electrons or heavy positrons, but their exact mass and charge have not been measured. It also appears that mesons decay spontaneously after a very short average life—about two microseconds. Just how mesons

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G.E. experts (above) inspect the "doughnut," a vacuum tube in which electrons whirl around and strike target. Tube neck at far left shows location of target, which emits powerful X-rays that leave tube at Bakelite circlet on rim.

Rear view of betatron (left) shows tail of electron gun behind white board in center. Similar to those used in cathode-ray tubes, gun provides electron stream. Top of giant thyratron that triggers deflection circuit is at lower right.

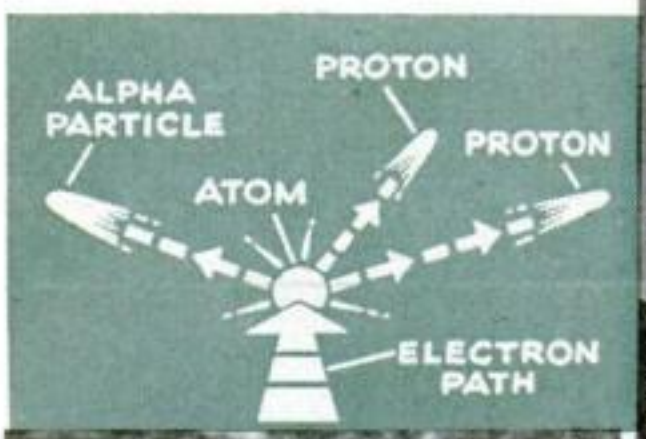
are produced and just what they decay into are still secrets of nature that scientists hope the biased betatron will help to solve.

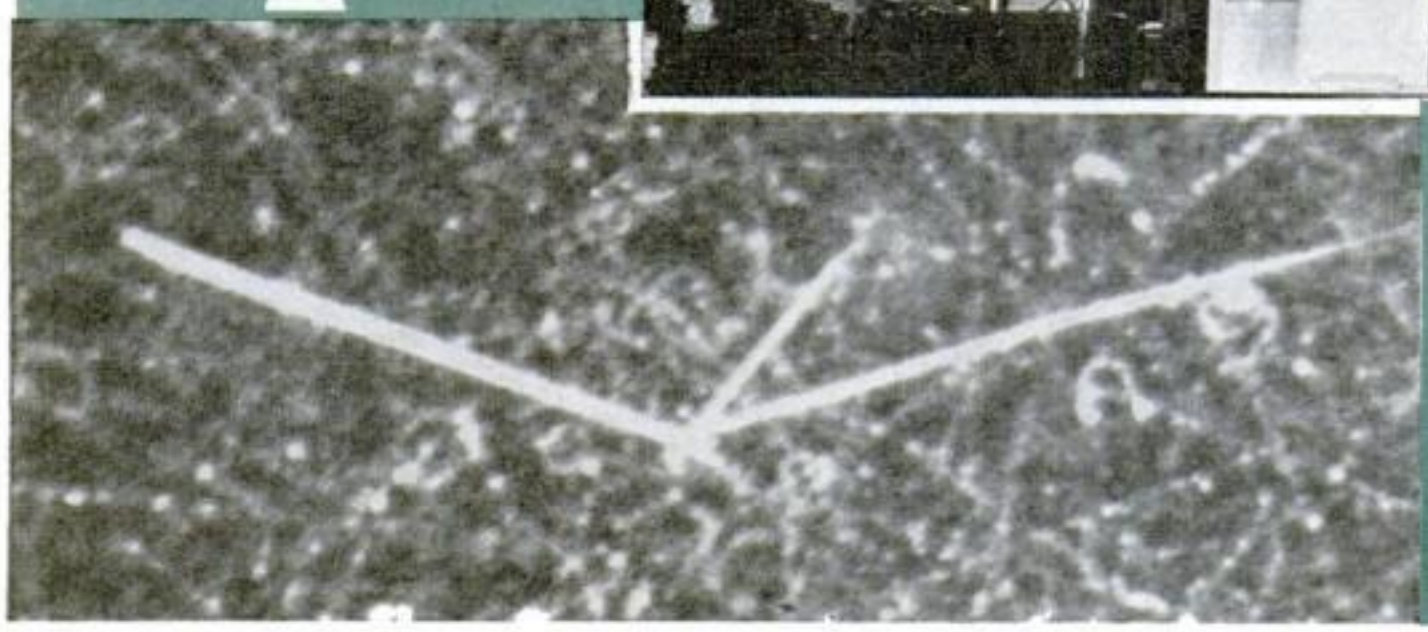
The biased betatron will also be useful in industry. In five minutes, a 10,000,000-volt betatron can study the insides of 12-inch steel—three times the penetration of an ordinary 1,000,000-volt industrial X-ray machine. Another line of betatron research is in medicine. The more energetic radiation becomes, the more deeply it penetrates the human body. More important, the cone of

Betatron operator, responsible for its wiring, pouring liquid air into the doughnut's exhaust pump. Like other large vacuum tubes, the doughnut is permanently connected to a high-vacuum pump that runs constantly to keep out stray material.



G.E. researcher peers into camera of big cloud chamber where betatron's X-rays leave visible tracks in air supersaturated with water vapor. Lead blocks at right beam X-rays so that only concentrated cross section enters chamber.





Picture and diagram show what happens inside chamber. Heavy track at left is high-speed alpha particle; two lighter tracks, protons; little squiggles, random electrons.

penetration is sharper and narrower. A low-voltage X-ray shows a profile resembling a ragged paintbrush. But X-rays of 10,000,000 to 50,000,000 volts show a picture resembling a sharp-pointed draftsman's pencil. So promising is the medical use of the biased betatron that G. E. is building a 50,000,000-volt unit. With such a tool, medical researchers can study diseases deep within the body.

At present the biased betatron offers the brightest hope for higher laboratory voltages. But G. E. scientists are quick to point out that there are other highly promising devices. One is the synchrotron, suggested independently by the Russian physicist, J. Veksler, and Dr. E. M. McMillan of the University of California. This combines the principle of the betatron with that of radar; the electrons obtaining additional push by going through a high-energy cavity resonator, similar to the vacuum-tube circuits that produce the intense energy pulses of radar. Scientists hope to build a half-billion-volt synchrotron with only a 400-ton magnet. A 70,000,000-volt trial model will be ready for testing by the end of the year, and G. E. is building parts of the magnet for a 300,000,000-volt machine for Dr. McMillan's group. Another device, on which Massachusetts Institute of Technology and other groups are at work, is the linear accelerator (PSM, Sept. '46, p. 83), in which atomic particles are shot through a long metal tube to build up their voltage.

To scientists, even now talking of 10-billion-volt machines, it does not matter which device achieves higher voltages. What they want is energy enough to pound all the remaining secrets out of the atom.

Caught by Camera at BIKINI

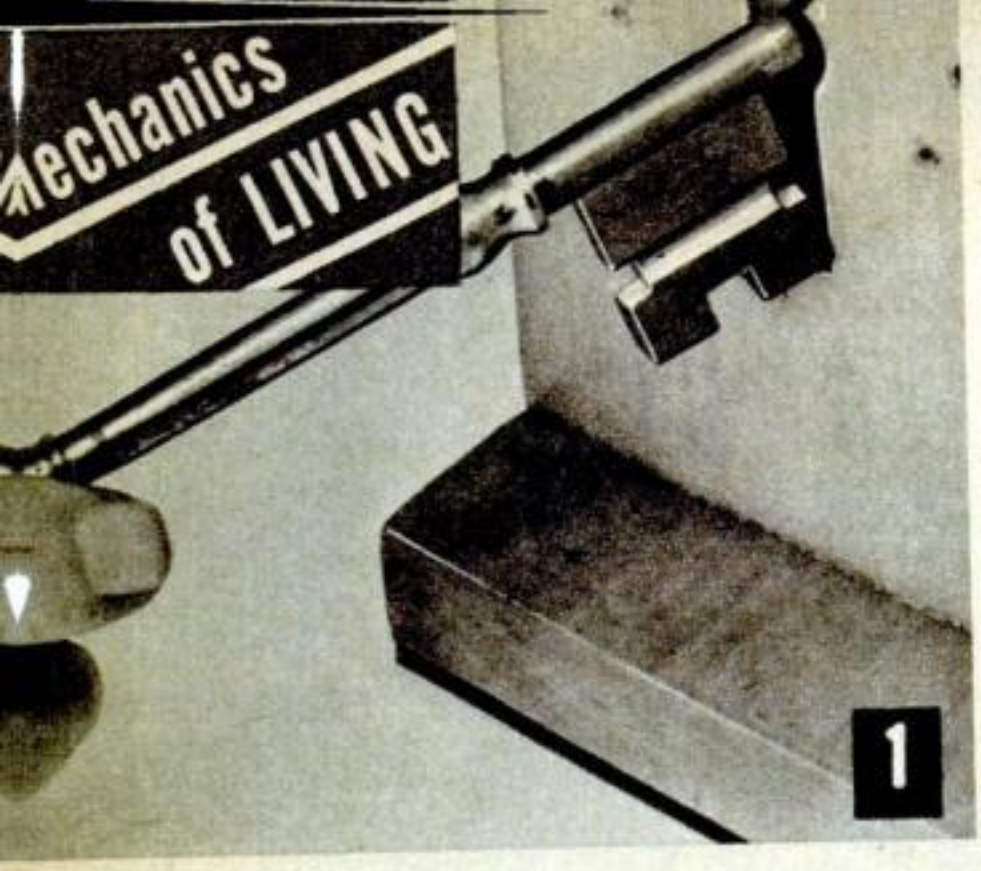
The eye of a fast camera, watching an atomic bomb explode at Bikini on July 1, caught this striking color picture of the radioactive cloud's swift, swirling rise through the cloud layer over the target area. Bikini Atoll is silhouetted against the bright mass of steam surrounding the base of the many-hued pillar.

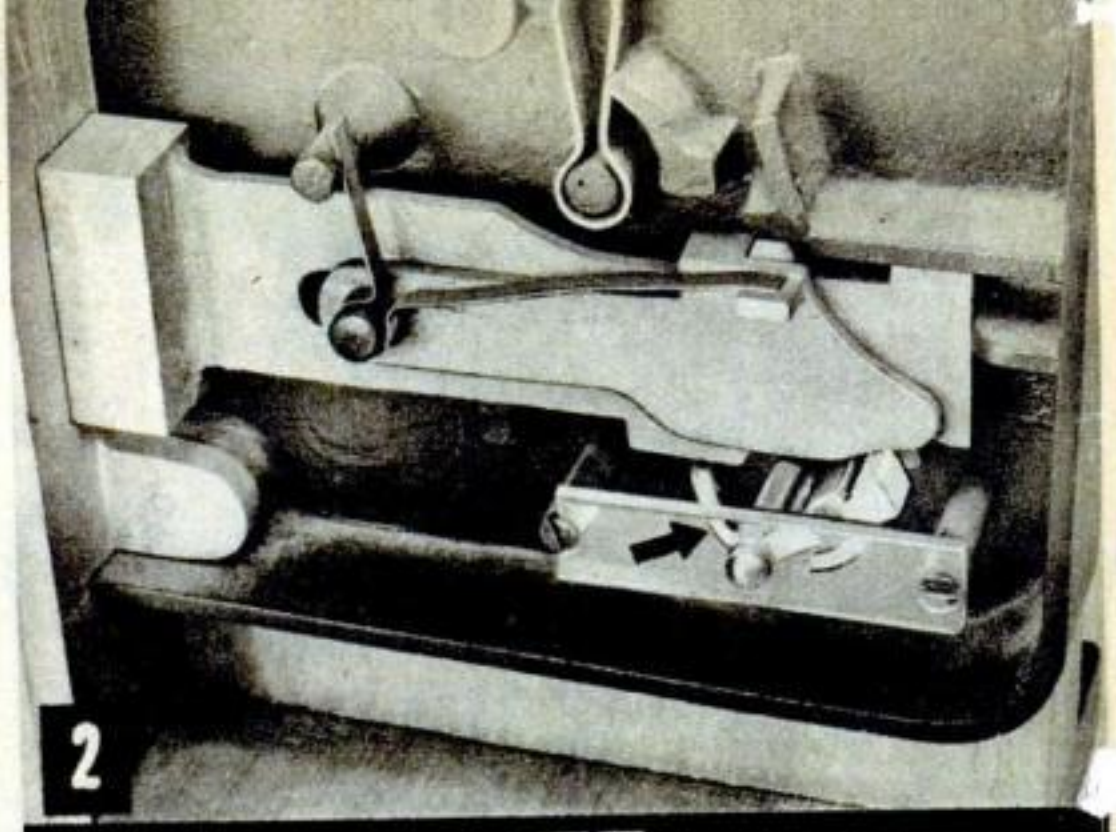
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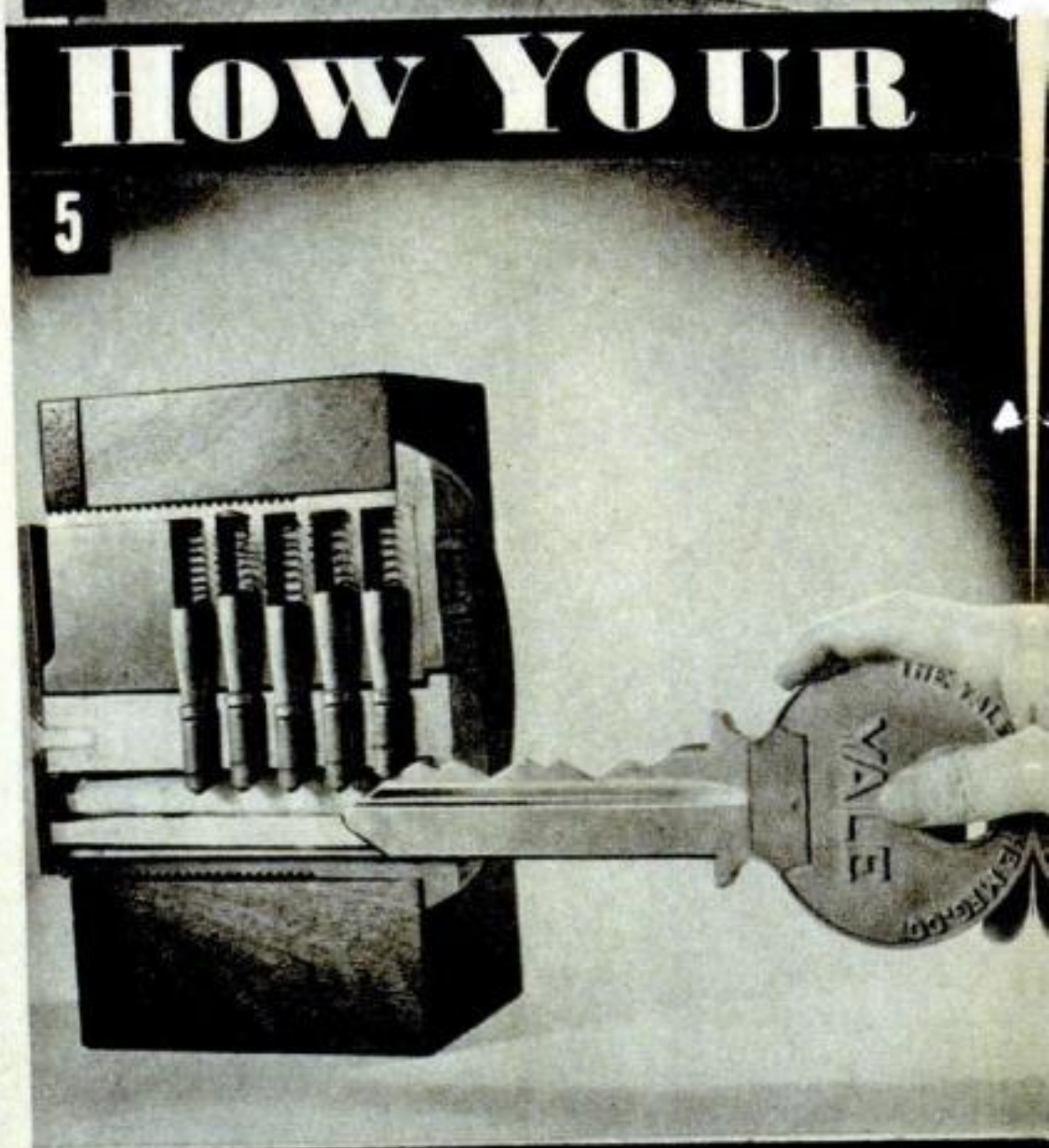
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echanics of LIVING





HOW YOUR





PSM photos by W. W. MORRIS

1. The simplest, most common door lock is the single-tumbler type, the workings of which are exposed here in an oversized model. The slots in its key are called wards. They are mated with projections inside the lock to permit the key to turn. This type of lock gives little protection since an ordinary skeleton key will usually open it.

2. Inside a one-tumbler lock. The semicircular projection (arrow) just inside the keyhole fits a notch in the rear edge of the key and prevents a strange key from turning.

3. As the key turns, the notch or bitting in its bottom edge permits it to pass along the back of the irregular tumbler (arrow) fixed to the bolt. Without this notch the key would be stopped.

4. The turning key hits a projection (arrow) that throws the bolt forward. The rear-edge ward now rides the semicircular track again and the key can swing around to its starting point.

5. The pin tumbler lock, invented by Linus Yale, Jr., in 1864, was a big step forward. Five small pins, divided at varying points along their shafts, must have these division points lined up perfectly before the key can turn. This cutaway model of a lock, several times actual size, clearly shows that before the key is inserted the pins are held at irregular levels, keeping the cylinder from turning.

6. Insertion of the key lines up the division points of the pins. The lower sections of the pins vary in length so that when each finds its proper notch in the edge of the key it will be lined up. Sloping edges of notches permit the key to enter, forcing each pin up against its individual spring.

7. Here is how the whole lock looks before the key is turned. The cylinder containing the pin tumblers is in the upper right-hand corner. The lever on the end of the cylinder throws the bolt.

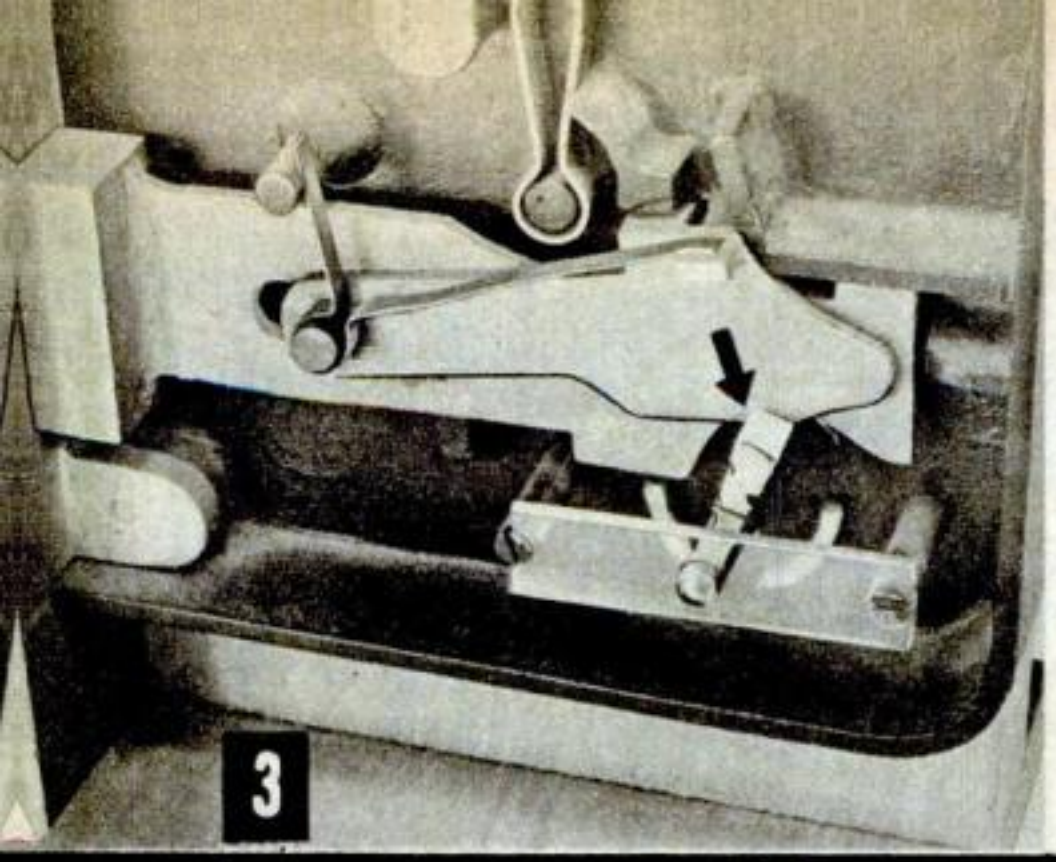
8. As the key turns, the pins divide along the edge of the cylinder, permitting it to revolve. The lever that throws the bolt, screwed to the end of the cylinder, is beginning its turn.

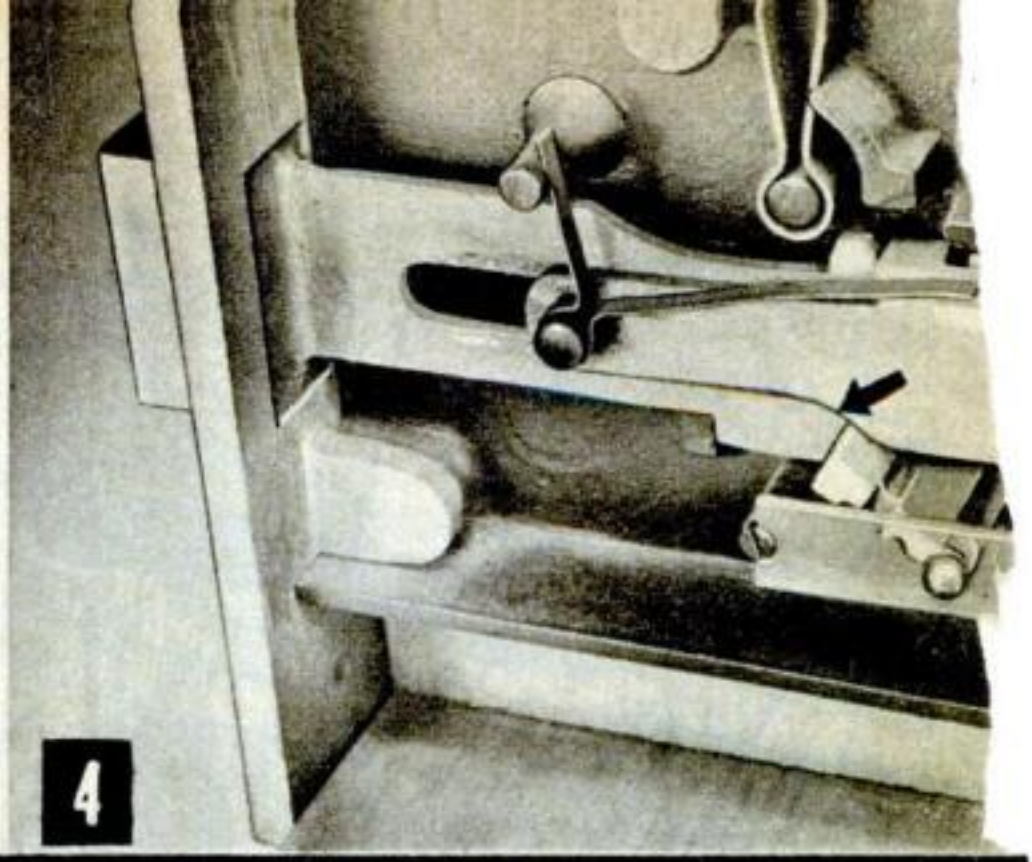
9. Here the lever on the end of the cylinder is partly turned, engaging the bolt.

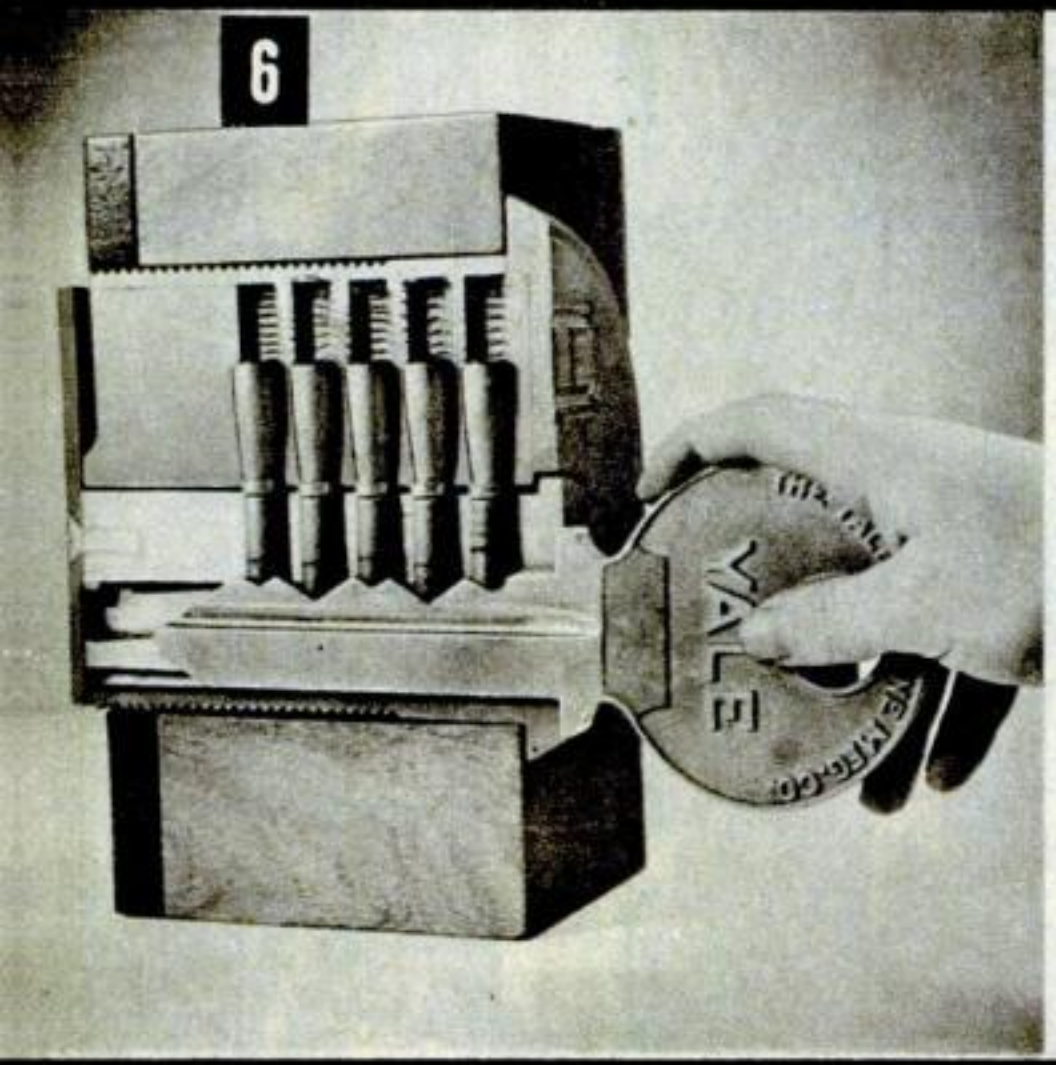
10. The key has turned the cylinder far enough to push the bolt forward and lock the door. The cylinder can now finish its circuit. When the key is withdrawn the pins will fall out of line again, freezing the cylinder into place.

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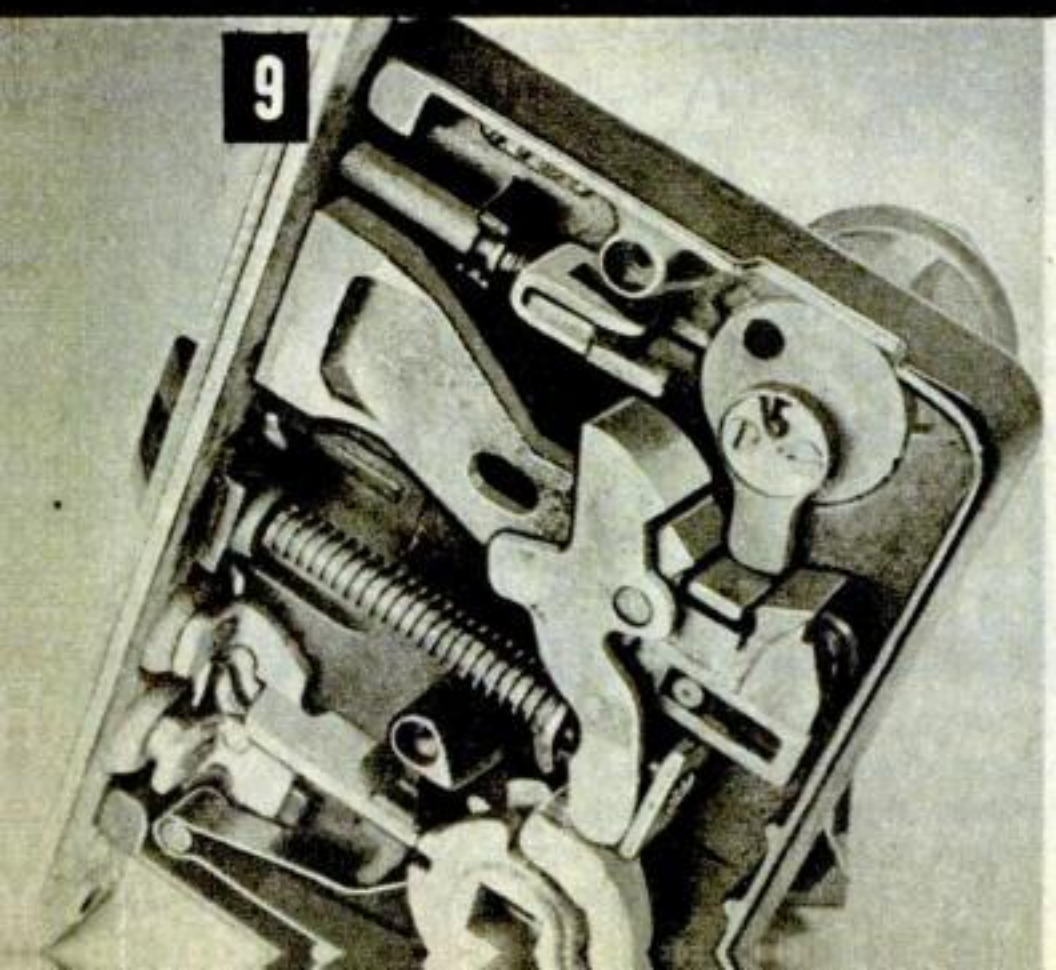
HOME LOCKS WORK





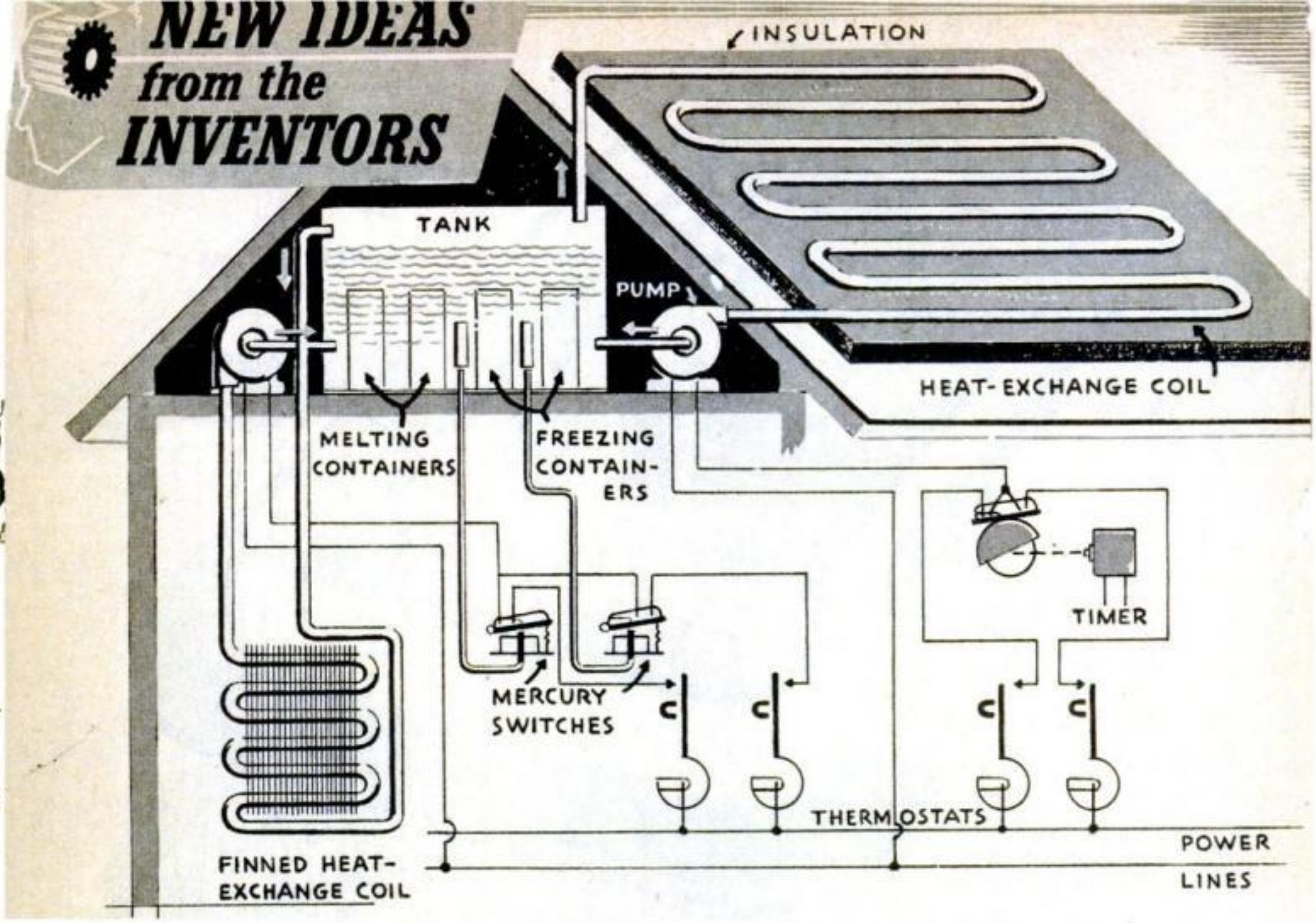


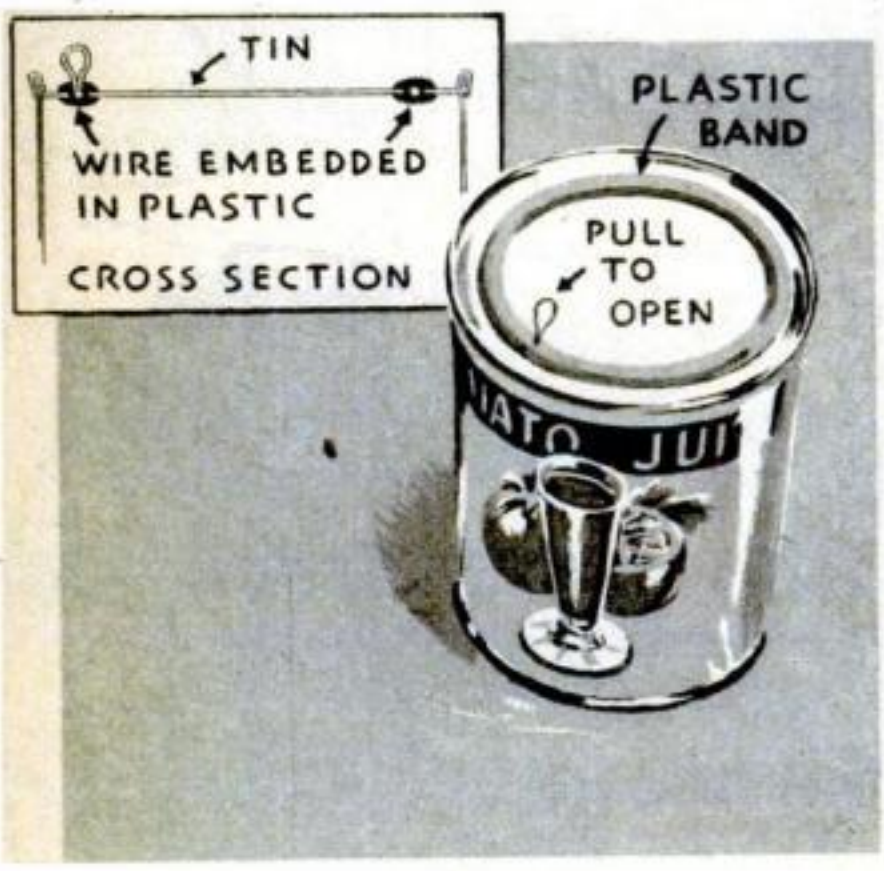






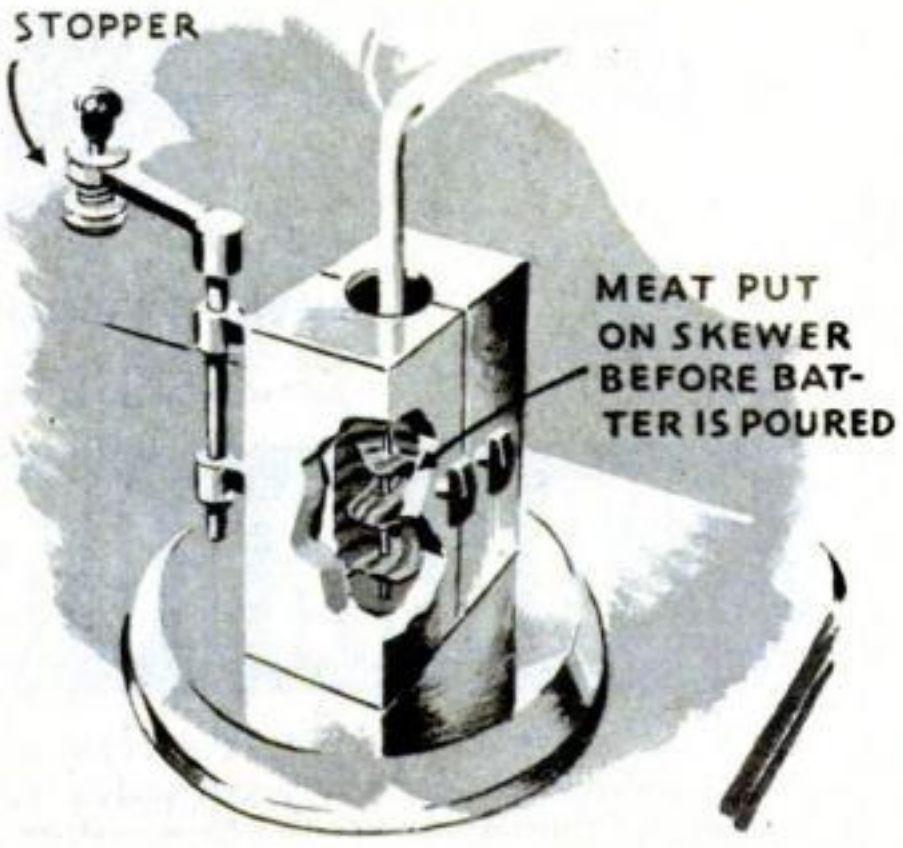
NEW IDEAS from the INVENTORS





Safety Opener for Tin Cans. Coming up with an idea that should endear him to housewives and sharply curtail the volume of male profanity in kitchens, E. Storus, of Toronto, has designed a tin can (above) that opens at the pull of a wire. In his invention, a large, neat hole is cut in the top of the can when it is filled; then the removable circle of tin is sealed in place by a plastic band with a wire loop embedded in it.

Vertical Waffle Iron. Two men who wanted a more practical way to bake waffles containing bits of sausage, bacon strips, or other meats have fulfilled their wishes by slightly altering a conventional waffle iron and turning it on edge (below). In this way the batter, which normally starts to bake the minute it touches the hot metal, is heated impartially on both sides as it is poured in. A. P. Gruenke, St. Paul, and B. E. Stair, of Sioux Falls, S. D., are the inventors.



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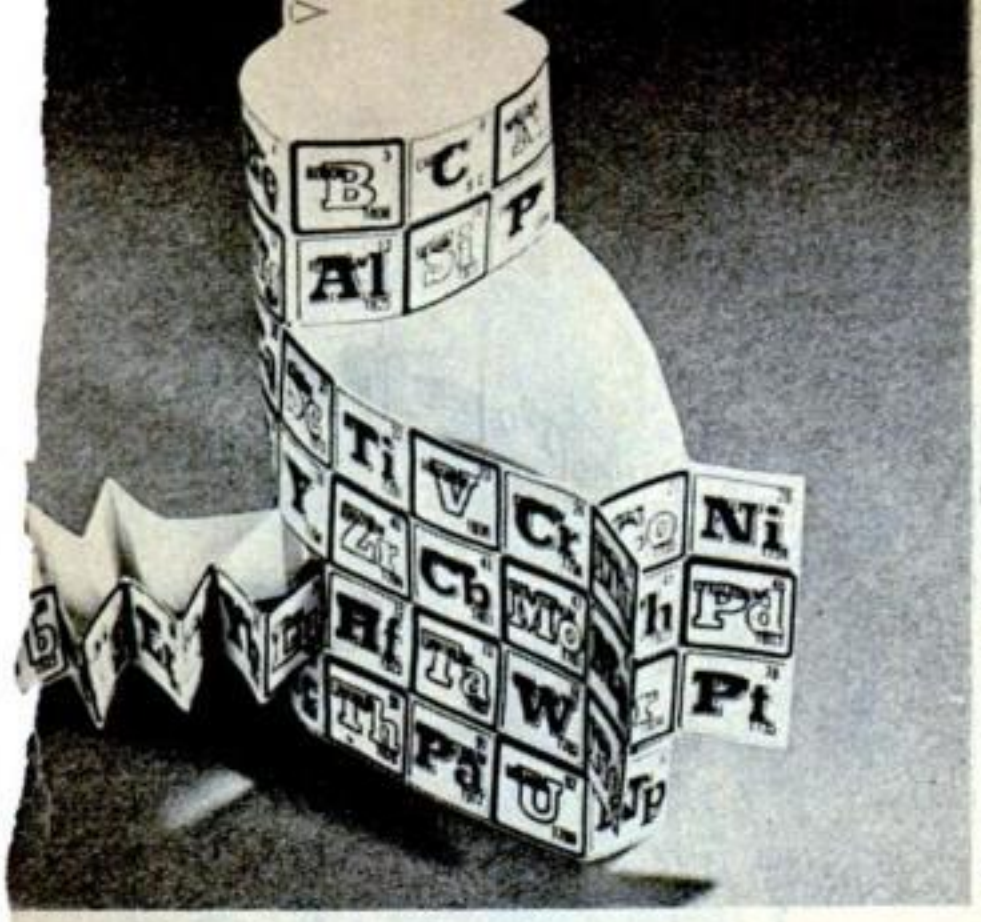
Radiation Heats and Cools. A solar heating system (left) that can also be used to cool the house in which it is installed has been invented by Alwin B. Newton, of Minneapolis. Mr. Newton proposes to capture heat from the sun in a familiar way: by means of a coil of pipe lying flat on the roof, within a glass-covered insulating case. The heated water or other liquid in the coil would be circulated to an attic tank, its heat-storing capacity augmented by containers holding Wood's metal, which melts at 130 degrees F. Reversing this process at night, the inventor would send water from the thermal storage tank through the roof coil, where it would radiate its heat into space. The cooled liquid would return to the tank, whose cold-storing capacity is increased by another set of containers holding a substance that freezes at 50 degrees F.

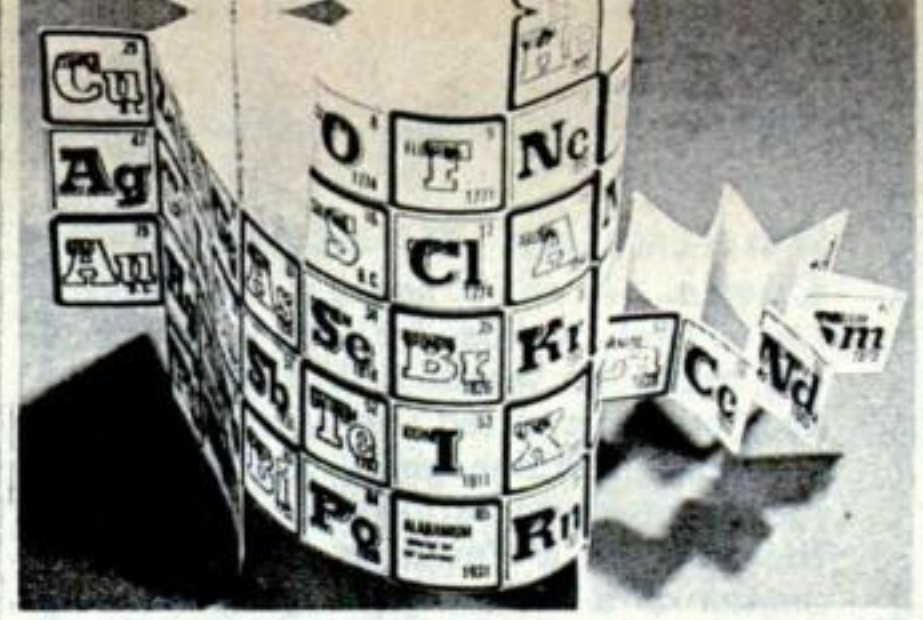


Trap for Ripe Fruit. A new fruit picker (above), designed by Peter Metzger, of Anaheim, Calif., consists of a canvas bag at the end of a stick, the bag's mouth being shaped roughly like a pear upside down. Beside the stem end of this opening is a cord-operated cutter that snips off each piece of fruit as the bag closes over it.

Aids for Canning. Simple but effective devices to make canning easier have been invented by Margaret T. Sturr, of Haddon Heights, N. J., and Cecil B. Woodruff, of Detroit. Mrs. Sturr's gadget (right) consists of a pair of wire jaws at the end of a looped handle. A locking device that slides down the handle causes the jaws to clamp around the top of a jar, which then can easily be lifted out of boiling water. Mr. Woodruff has invented a means for tightening or loosening jar covers. It is a round, slightly convex piece of metal with a hole in the top. The inner rim of the hole grips the cover of an inverted jar. The utensil can be screwed to a table top.







BUILDING

bove are two views the "castle of ele- ents" devised by M. ourtines, a French ysicist, to show the lationship of ele- ents. Pictures on pages 106 and 107 plain how to con- uct the castle.

By **HOWARD W. BLAKESLEE**
Science Editor, The Associated Press

					1 HYDROGEN H 1766	2 HELIUM He 1895
5 BORON B 1808	6 CARBON C B. C.	7 NITROGEN N 1772	8 OXYGEN O 1774	9 FLUORINE F 1771	10 NEON Ne 1898	3 LITHIUM Li 1817
13 ALUMINUM Al 1825	14 SILICON Si 1823	15 PHOSPHORUS P 1669	16 SULPHUR S B. C.	17 CHLORINE Cl 1774	18 ARGON A 1894	11 SODIUM Na 1807
29 Cu B. C.	30 ZINC Zn 1746	31 GALLIUM Ga 1875	32 GERMANIUM Ge 1886	33 ARSENIC As 1250	34 SELENIUM Se 1818	35 BROMINE Br 1826	36 KRYPTON Kr 1898	19 POTASSIUM K 1807
47 Ag B. C.	48 CADMIUM Cd 1817	49 INDIUM In 1863	50 TIN Sn B. C.	51 ANTIMONY Sb 1450	52 TELLURIUM Te 1782	53 IODINE I 1811	54 XENON Xe 1898	37 RUBIDIUM Rb 1861
79 Au B. C.	80 MERCURY Hg B. C.	81 THALLIUM Ti 1861	82 LEAD Pb B. C.	83 BISMUTH Bi 1753	84 POLONIUM Po 1898	85 ALABAMIUM (detected but not confirmed) 1931	86 RADON Rn 1900	55 CESIUM Cs 1860
TAB B								87 VIRGINIUM (detected but not confirmed) 1931

The two bottom strips contain 15 "misfit" elements—the rare earths, which form an accordionlike projection on the castle.

RARE EARTHS

57 LATHANUM La 1839	58 CERIUM Ce 1803	59 PRASEODYMIUM Pr 1885	60 NEODYMIUM Nd 1885	61 ILLINIUM Il 1926	62 SAMARIUM Sm 1879	63 EUROPIUM Eu 1901	64 GADOLINIUM Gd 1880

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BLOCKS of SCIENCE

THE periodic table of the elements—the 96 metals, nonmetals and gases that form everything in the material universe—is the blueprint of the atomic future.

This table states a very simple fact: Everything material is made of three kinds of particles; namely, neutrons, protons and electrons. The difference between any two elements, iron and oxygen, for example, is in the number of particles.

On a map, specific places are always at specific points. The periodic table is like that. It tells facts about the elements that never change.

Although the table does not show where to look for uranium, it indicates the likely mineral formations. It shows that the kind of chain reaction that makes uranium bombs cannot be achieved without uranium's aid. It also gives the limits of the uranium reaction and guarantees that it will not explode the earth.

The periodic table points the way to some yet-unachieved human desires. One of these is atomic energy from less costly materials and suited to industrial uses. The table shows that uranium lies in an atom-splitting range. Already the periodic indicators point to another range where unknown atomic energies may be gained by a new process.

The table predicts metals, now nonexistent, that may be produced by transmutation. In fact, its guidance already has produced synthetic metals not known to exist anywhere else in creation.

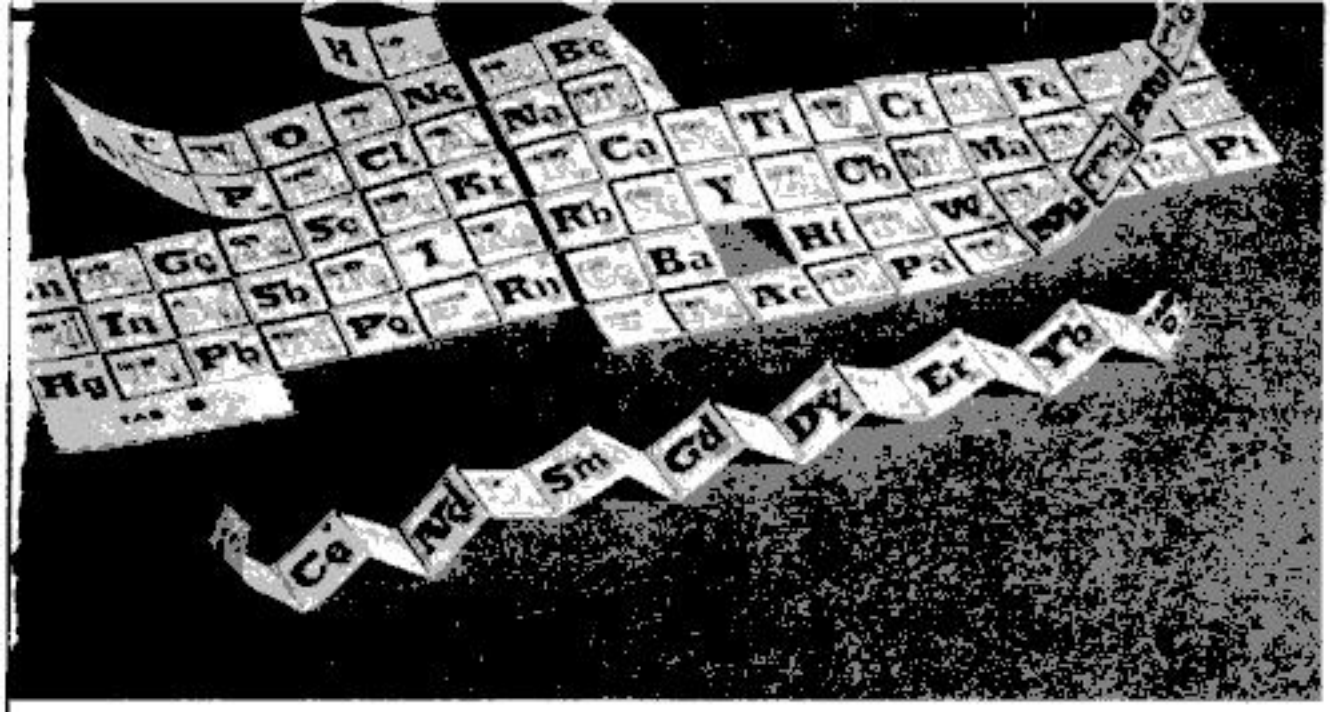
The table describes the basic physical structure of everything, whether molecule, man, or star, with man at the midpoint in this trio. How can the three little particles on which the table is based tell so much? The answer is in their rhythmic organization into the units called atoms.



This version of the periodic table, designed to be cut out and made into a Courtines castle, gives the name, atomic number, symbol and date of discovery of each element. Several elements, notably 93, 94, 95 and 96, have only recently been added to the table.









After cutting out the table on the two preceding pages, join the two halves, with tape or by pasting on a strip of paper, so that blocks 3 and 4 are on the same line. Join the rare-earth strips, block 64 to block 65. Then cut, from the left, beneath block 1 and beneath blocks 13-14-15; from the right, cut above blocks 93-94-95-96.

Fold block 1 around and paste it to the back of block 2. Fold tab A inward and paste its face to the backs of blocks 5 and 13, forming a circle.

Every atom has two sections. One is a center, or nucleus, composed of a knot of neutrons and protons (except hydrogen, whose nucleus is a single proton). The other is a shell, or a series of shells, surrounding this center. There are never more than seven shells, and they are not material, merely zones in which electrons circulate in orbits around the nucleus. There are never more than 32 electrons in one zone. They travel hundreds of thousands of miles an hour in their orbits. All atoms are about the same size, the heavier ones merely being more concentrated.

Frame Before Picture

This picture is not guesswork; it is drawn by X-rays and other tools, but it has taken nearly 200 years to fill it in. The first clues were found by using ordinary scales. The early chemists weighed elements and compounds with utmost care, as if realizing that they were dealing with something built of units too small to see. These dimly sensed particles seemed always to be units, never fractions of a unit. More than one chemist said that the compounds behaved like the octaves of a musical scale.

One of the first to interpret the story of the scales was Antoine L. Lavoisier, a French chemist. In 1774, he pointed out that the total weight of elements was never changed by chemical reactions.

Five years later another French chemist, Louis J. Proust, observed that the proportions of each element in a compound never changed, no matter how it was prepared.

In 1808, in England, the first explanation of the numbers puzzle was offered by John Dalton, son of a weaver. He said the unseen units must be atoms, the ultimate particles of matter conceived by a Greek philosopher, Democritus, 2,200 years before. Dalton argued that atoms had to exist to explain the rhythmic way in which a fixed amount of one element always combined with a definite amount of another.

But a different sort of rhythm finally disclosed the periodic table, in 1869, to Dimitri Mendeleyev, Russian chemist and teacher. The rhythm he saw was valence, which means the combining capacity of an atom—its ability to hold or displace other atoms in a compound—measured in multiples of the hydrogen atom, which has the weight of one unit. More simply, valence is the affinity of one element for others.

The Rule of Eight

Mendeleyev arranged the elements by weight, in ascending steps starting with hydrogen, and an astonishing fact became apparent. A rule of eight was at work. Each eighth element, up the scale, had similar affinities. Lithium, for example, is number three in the table. Eight steps up is element 11, sulphur. It has the same valence as lithium. Up eight more steps is element 19, potassium, which again combines like lithium and sulphur.

Mendeleyev found eight of these families, each with its own distinctive valence. He then wrote the periodic table classifying these families by weight. The weight differences were fairly regular, but there were gaps. Mendeleyev reasoned that the gaps represented missing elements, and boldly counted the empty spaces as if they existed. He predicted that elements would be found in three of them, and within 17 years all three predictions came true. Since then, all the missing elements but two have been found, and these two have been reported.

The periodic table has been much improved. Today it is known that there are exceptions to the rule of eight, and that as elements become heavier, the interval is likely to be greater. But Mendeleyev's eight

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Paste blocks 28-46-78 to the backs of blocks 29-47-79. Put paste on the backs of blocks 25-43-75 and blocks 26-44-76; then pinch them together.



Beneath the two projecting wings formed by the previous step, paste blocks 94-95-96 to the face of tab B, leaving block 93, unpasted, beneath block 77 between the wings.



Cut out rare-earth block (57-71). Fold rare-earth strip, accordion fashion. Paste the face of tab C to back of block 56, face of tab D to back of block 72.

families are still there. The reason for the families is in their outer shells of electrons. These outer electrons do the amalgamating when one atom joins a different kind of atom to form a compound. They are the valence electrons; each family has a different number of them. Mendeleyev's lithium family, the alkali group, has one. Group two, the alkaline earths, has two. And so on, up to eight.

Rare Earths' Behavior

There are other groupings based on electron behavior. One group, the rare earths, reverses ordinary atomic procedure. Usually an atom taking on an added electron places it outside. Not the rare earths; they put the new electron in an inside shell.

The periodicity of electrons is now perfect. Their numbers, in each atom, run without a break in sequence from one, for hydrogen, to 96, for the newly synthesized heaviest atom, curium.

The atomic weights rise in rhythmic progression. The building units are neutrons and protons, virtually equal in weight. Electrons do not count, being almost weightless. The atom weights usually rise by two or three units for each step, although there are exceptions. Add one unit to an atom, and it is either transmuted to a different element or to an isotope of the same element. An isotope has the same *chemical properties* as the basic element, but a different *weight*.

This precise chemical similarity is now challenged, however, and the challenge carries vast possibilities. Thanks to the periodic rhythm of weights, scientists can make many isotopes and have already synthesized about 500. By the same periodic rhythm, they are making entirely new elements, all to date being heavy metals. With atomic ovens for transmutation chambers, there is no limit now in sight for this synthesis. The ovens have made two dozen new isotopes and some new elements. For the first time, elements have been synthesized in visible amounts.

The previously mentioned exceptions in the rhythm of atomic weights are caused partly by another rhythm, that of energy itself. Atomic units lose a slight fraction of their mass when they join up to form a new atom. This lost mass changes into energy, used in welding the new atom.

Where Future Energy May Lie

Conversely, a similar amount of energy is required to break the same atom, and it is by this breaking that atomic energy of the future may be gained. The energy rhythm shows itself in a wave that covers the periodic table from end to end. All the middleweight atoms require more energy to break than the light or heavy atoms at either end of the table. This wave is a smooth curve, its hump in the middle.

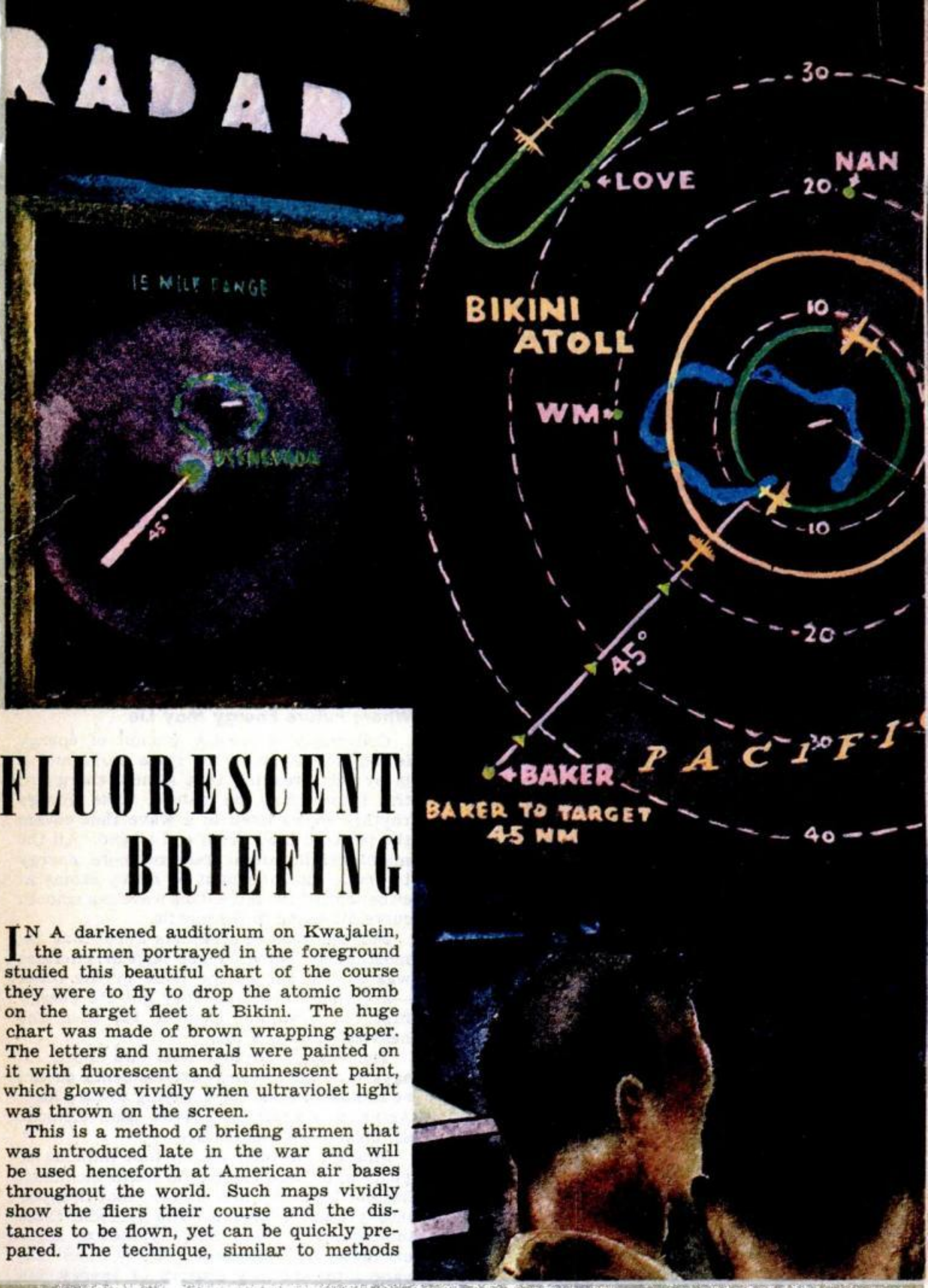
For this reason, scientists knew that the most likely place to get nuclear energies was at one end of the table or the other —and that was where they got the energy first: in uranium, element 92, then the heaviest known atom.

The energy rhythm tells still more. It says that all the heaviest elements should be radioactive, slowly decaying toward lead. Actually, everything heavier than element 83, bismuth, is radioactive.

Finally, the table shows that millions of years ago there existed on earth elements, heavier than any now known, that decayed into present elements. The periodic table indicates how man may synthesize some of these lost elements. While man advances toward new sources of energy, his atomic blueprint can also turn back the pages to the earth's vanished past.

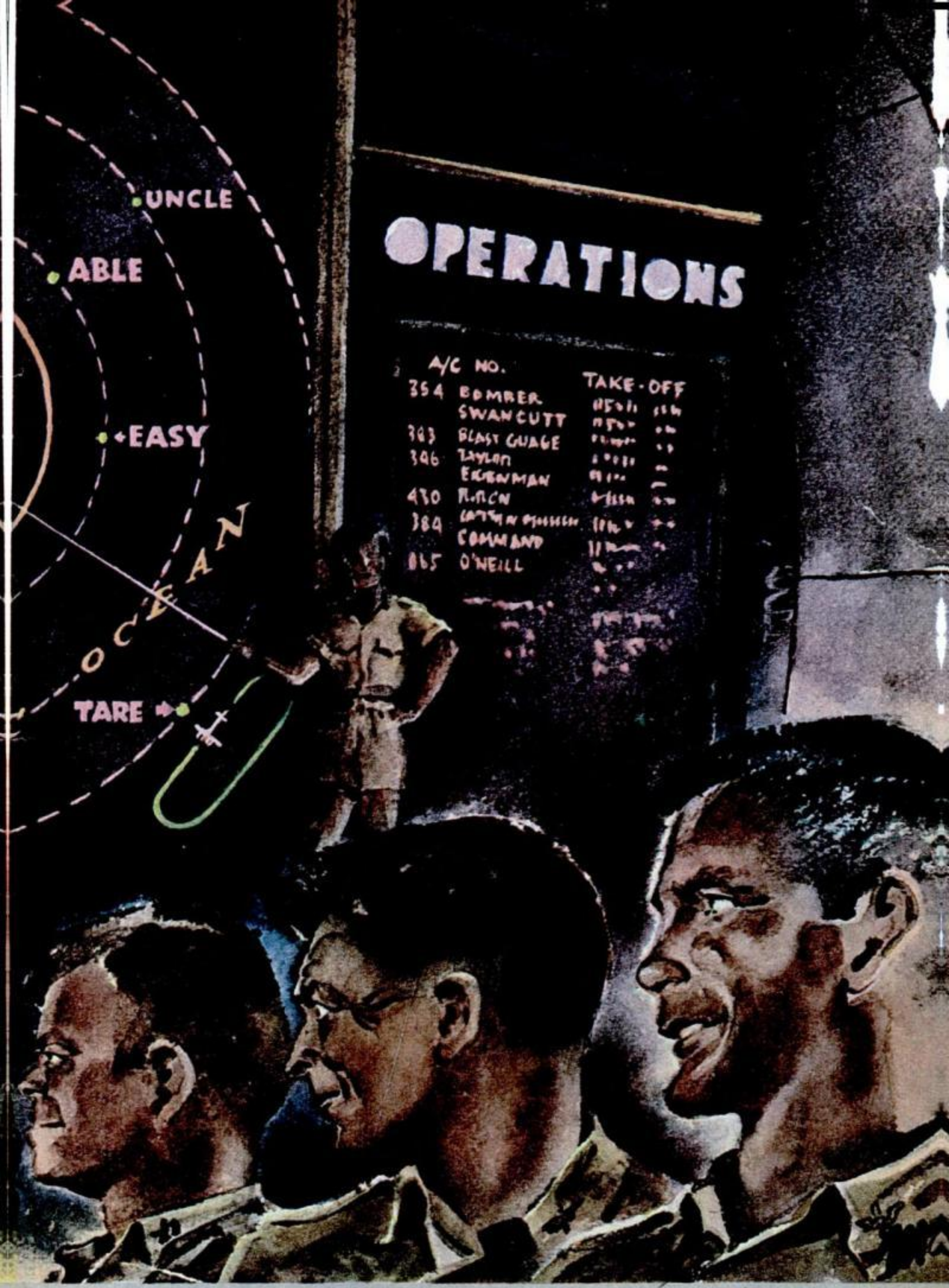
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FLUORESCENT BRIEFING

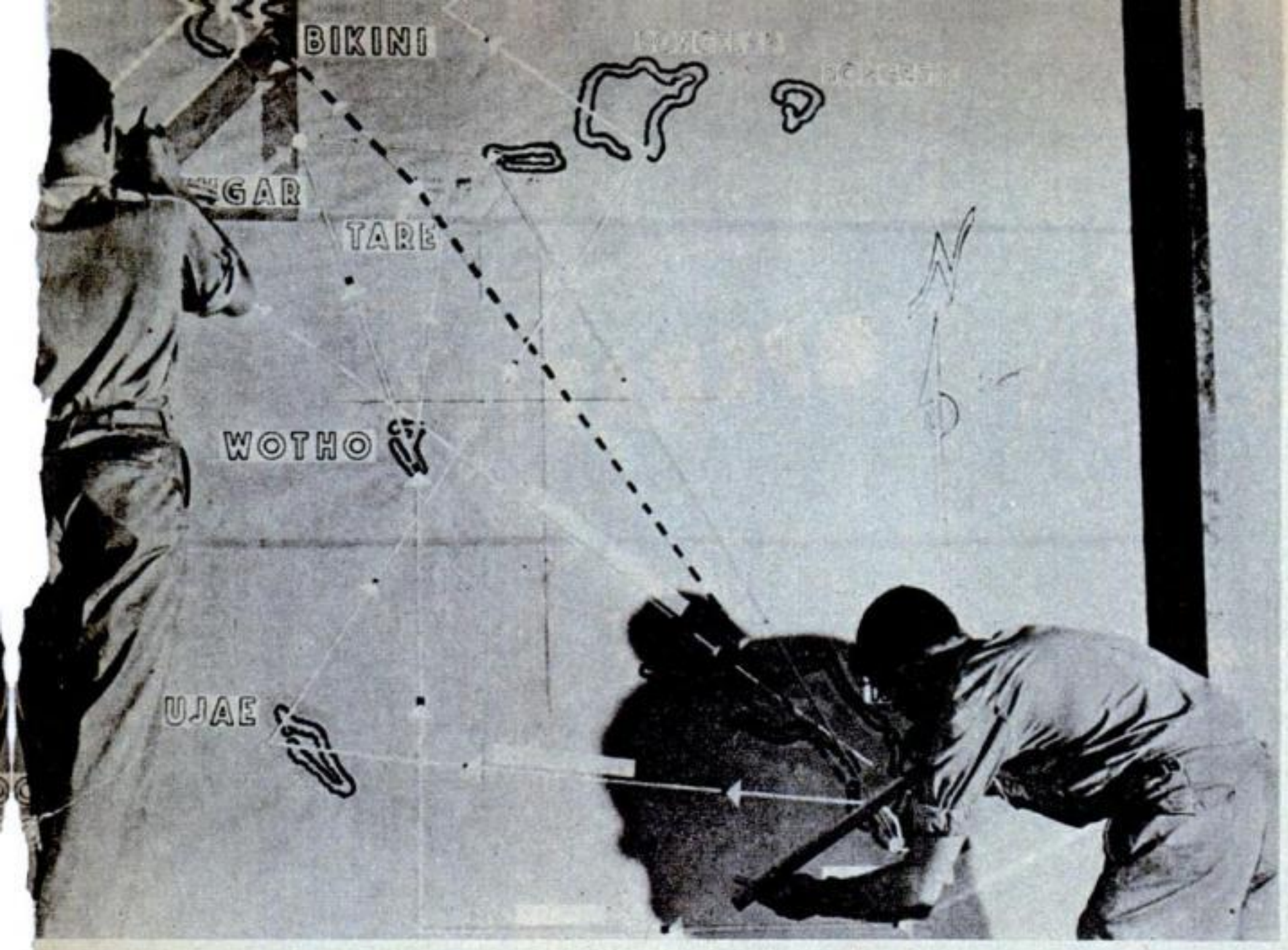


IN A darkened auditorium on Kwajalein, the airmen portrayed in the foreground studied this beautiful chart of the course they were to fly to drop the atomic bomb on the target fleet at Bikini. The huge chart was made of brown wrapping paper. The letters and numerals were painted on it with fluorescent and luminescent paint, which glowed vividly when ultraviolet light was thrown on the screen.

This is a method of briefing airmen that was introduced late in the war and will be used henceforth at American air bases throughout the world. Such maps vividly show the fliers their course and the distances to be flown, yet can be quickly prepared. The technique, similar to methods



HOW IT APPEARS IN ORDINARY LIGHT, TURN THE PA



employed by stage-set designers, was worked out by Major Ralph Kelly.

The painting reproduced on the previous pages was made at Bikini by Major Milton Marks, who was one of the Army's representatives in Joint Task Force No. 1.

Torpedo Attack. With these toylike devices the Navy trains its torpedo bomber pilots to hit targets. The cockpit on wheels, the mobile mount for the model carrier and the cart on which the tiny torpedo rides are all driven by electric motors at speeds exactly proportional to their size and the size of the floor. The pilot on the trainer fires the torpedo; the carrier is controlled separately (note operator's hand at left).

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Glass "PIPE" Carries 10,000 Conversations

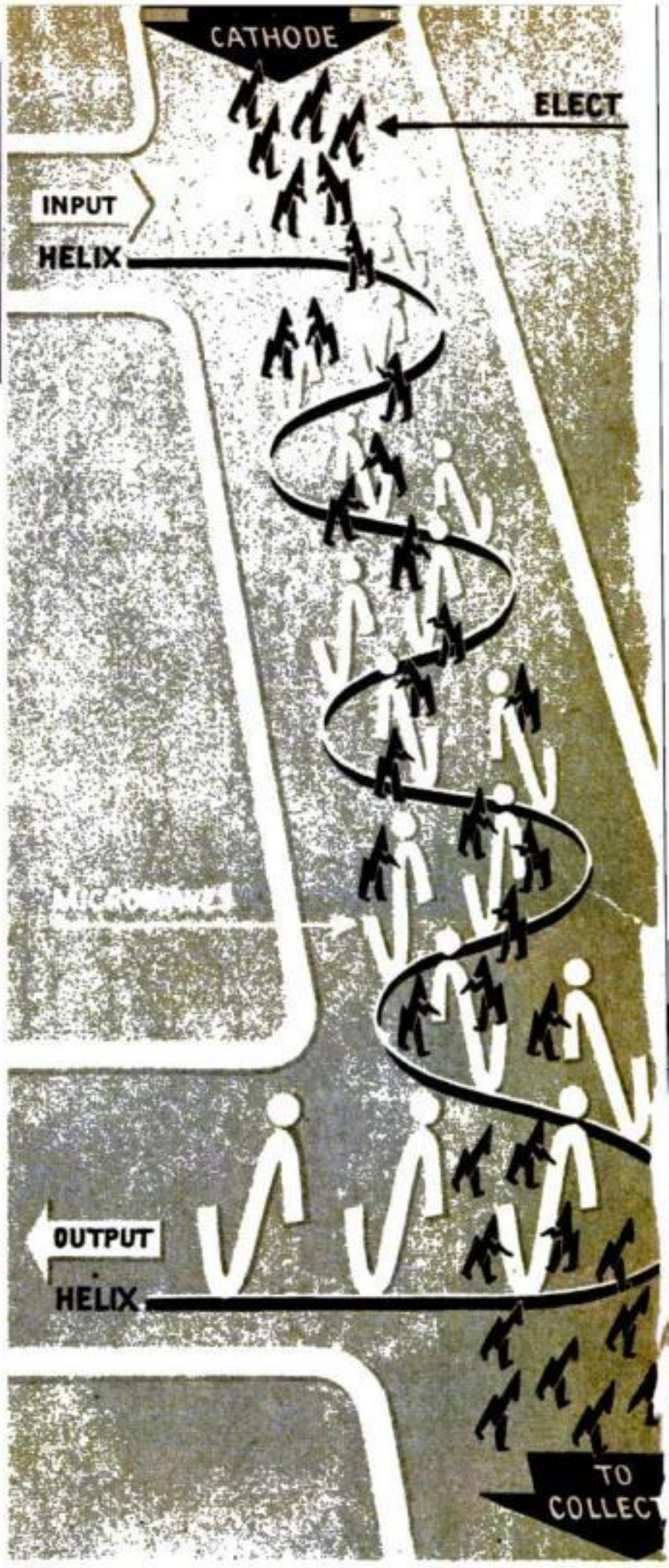
Slim new vacuum tube is radio's mightiest amplifier.

NATIONWIDE networks of ultrahigh-frequency radio stations that will relay telegraph messages and long-distance telephone conversations, as well as television and radio programs, will be possible in the near future. A completely new type of amplifier tube, developed at the Bell Telephone Laboratories, can handle simultaneously 40 full-color television programs, or 10,000 telephone conversations, or 100,000,000 words a minute by telegraph. The traveling-wave tube, as it is called, amplifies signals 10,000 times over a band 800 megacycles wide. Previous microwave amplifiers gave only small amplification over a narrow band, limiting the traffic that could be carried.

Radically different in appearance from the usual radio tube, the traveling-wave amplifier is a slim glass pipe more than a foot long. A bulb at one end contains the cathode, while the slender part of the tube is filled with a wire helix (coil). The microwaves travel around this helix, and are amplified by the stream of electrons shooting past the helix from the cathode. The electrons, moving slightly faster than the waves, give part of their energy to them, building up the waves' energy at their own expense. This interaction between electrons and radio waves has been compared by Dr. John R. Pierce, who directed development of the tube, to a breeze blowing past ripples on a pond. The breeze (electron stream) makes the ripples (microwaves) larger and larger as it blows along.

In developing the traveling-wave tube, Dr. Pierce was assisted by Dr. L. M. Field. The two men perfected an idea first suggested by a British scientist, R. Kompfner, of Oxford University.

Field tests of the new tube, which operates only at ultrahigh frequencies, beyond broadcast and amateur bands, are being planned. It may be tried out in the New York-Boston television link now being built.



The drawing shows how electrons shove the microwaves along the wire helix, or coil, in the new amplifier tube, boosting them enormously in volume. At right is the traveling-wave amplifier removed from its container. Below, the strikingly different vacuum tube is shown in a position for use. The bulb at its left end holds the cathode and the glass section carries the wire coil.

CRAFTWORK for CHRISTMAS

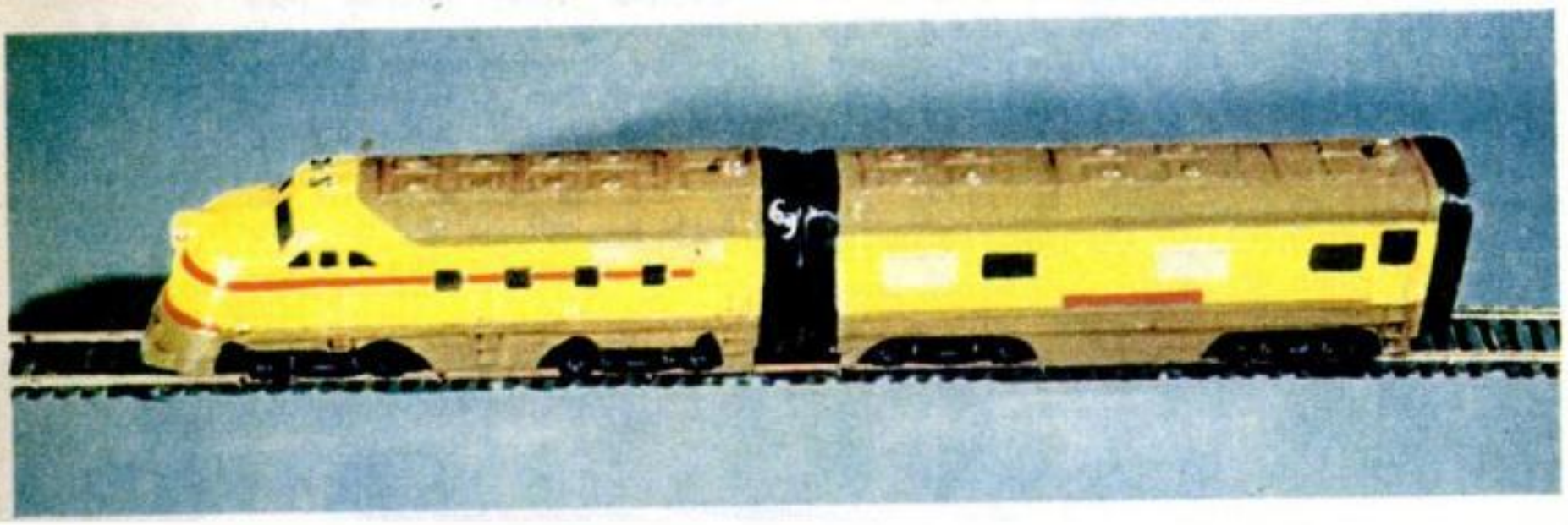




ALPHABET BLOCKS that lock together only in the proper sequence will give the younger child a lot of fun and a head start toward the first day of school. How you can cut out these or numbered blocks is described by Stuart Hoyt on page 151.

AN OVERNIGHT CASE tailored to her personal specifications makes an ideal Christmas gift for any woman. The handsome case shown here, an easy workshop project, was built of plywood and covered with imitation leather. Turn to page 152.

TOY LOCOMOTIVES and cars from the dime store are suitable for making an HO-gauge streamliner. Fit a model motor to one of these plastic toys, install a simple drive, set up your track, and you're ready to go. See page 164 for the details.



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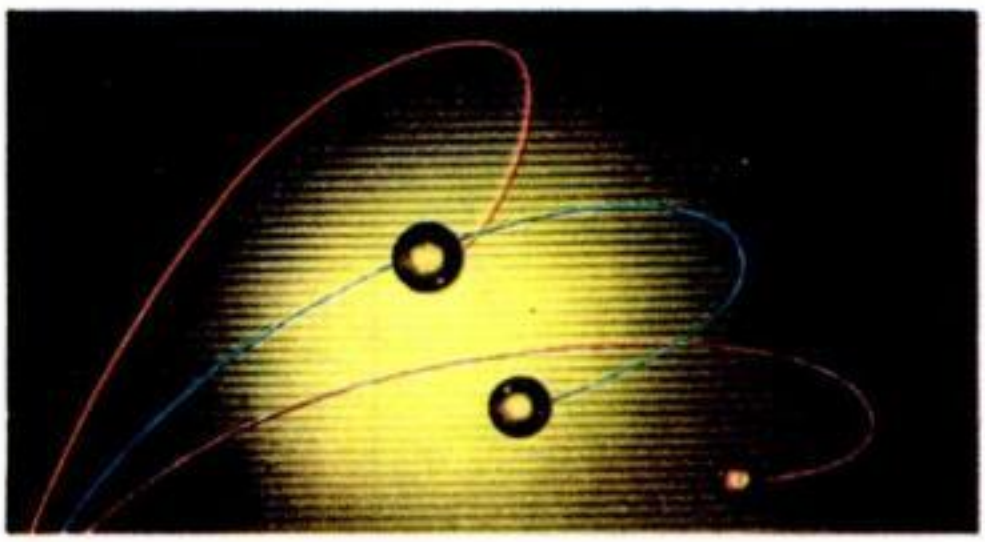
"Stratosphere over Harlem," showing that a silver cloud can have a fine, dark lining for the color camera.

TABLE-TOP WONDERLAND

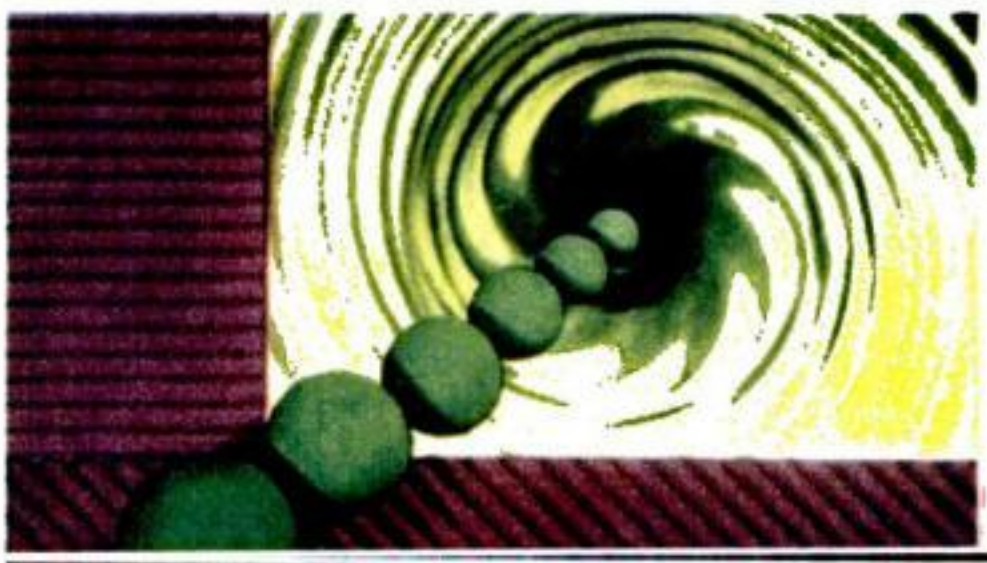
APPARENTLY the scope of color photography will never be exhausted. J. Clarence McCarthy now comes up with an idea —and a whole new bag of tricks and small-scale props—for striking table-top shots. Here are some of the results with his own treasured transparencies projected for the background. He tells on page 182 how this fascinating new hobby can be pursued and shows in drawings how the table sets for these and other photos were made.



This "She with Skis" was photographed, not on top of Mount Rainier, but on top of a table with a projected color transparency of Mount Rainier as background. At left, a color fantasy with green balls being drawn into a whirlpool.



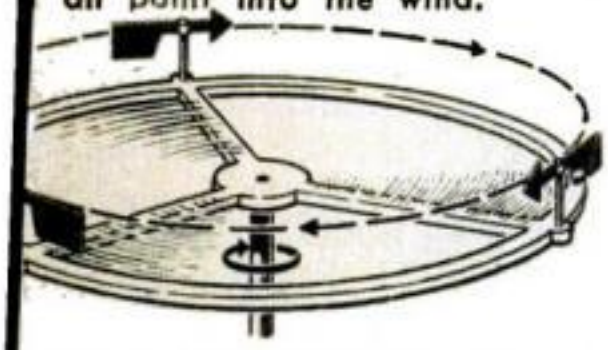
Golden planets flashing past the sun, an example of color-camera doodling for a striking effect.



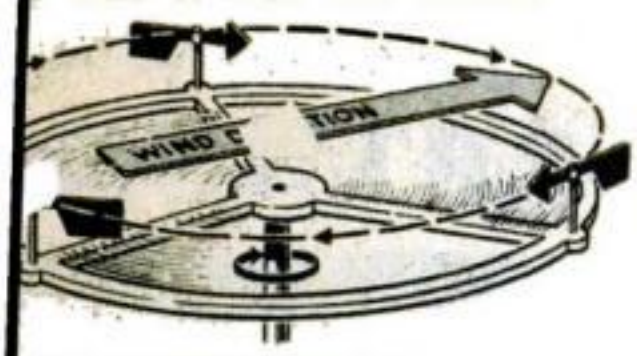
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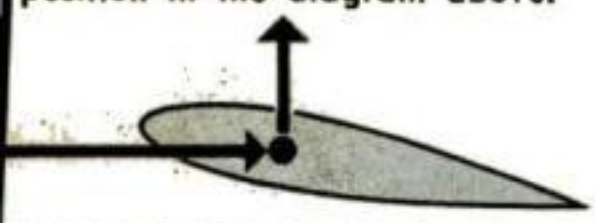
D DIRECTION (W in the big dia- below) is shown by fixed weather .. Three vanes on a stationary all point into the wind.



PHERAL VELOCITY (PV) is tangent circular path of travel. With no , vanes on a spinning wheel show s wind of their own motion.

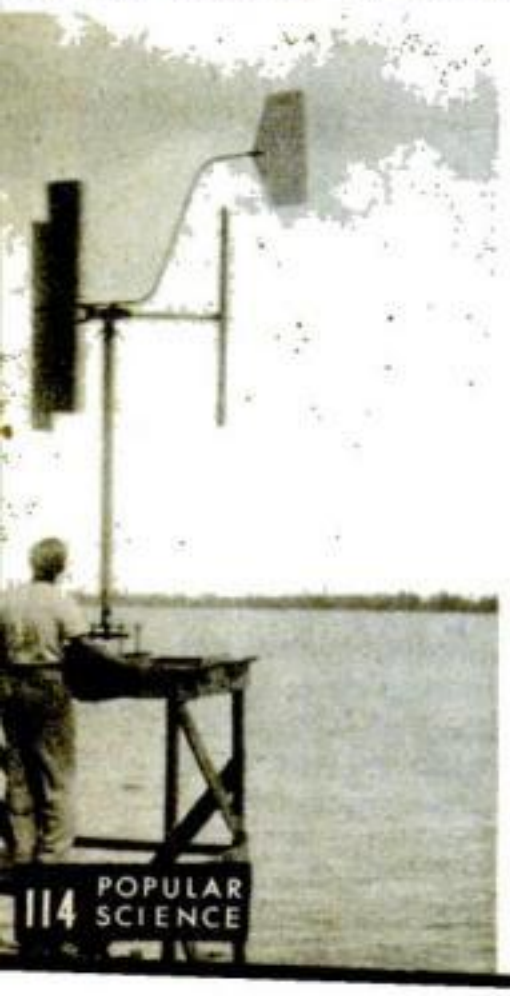


LATIVE WIND (RW) is a component motion-induced wind and an outside d. Note the shift of each vane from position in the diagram above.



SULTANT FORCE (RF) of relative nd on an airfoil, which is oriented a 5-deg. angle of attack to it, is similar to that of a plane wing.

right, force diagrams show w lift (RF) turns the axle. low, the windmill at work.



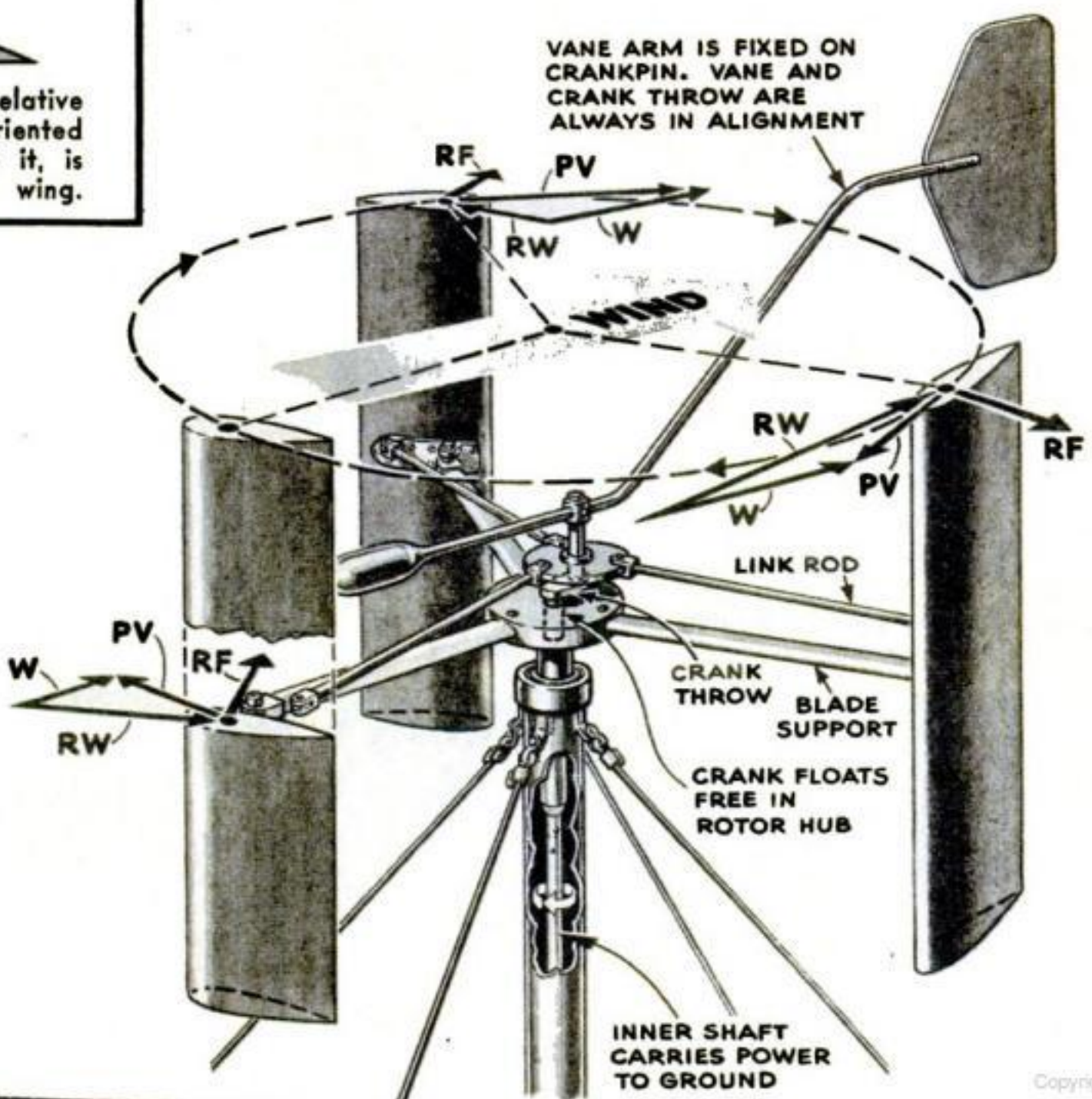
Winged Wheel

TURNS WIND INTO POWER

BLADES that develop maximum force when heading into the wind are a seeming paradox in a windmill developed by Jesse C. Donaldson, of Cocoa, Fla. An outgrowth of earlier work on a helicopter of his own design, the windmill makes use of the aerodynamic principles of both airplanes and sailing ships.

Airfoil sections like plane wings are mounted around a vertical shaft on pivots that permit a 20-deg. movement either side of their circular path. Rods linked to a crankpin governed by a directional vane automatically control the angles of the blades at every point. A force resulting from the movement of each blade through the wind, similar to the lift of a plane wing, is always directed ahead of the shaft, and so results in turning effort.

As all blade area is at the periphery and all the impinging wind tends to revolve the shaft, the device develops more torque than common windmills. Donaldson states it is 46 percent efficient as against 21 percent for a propeller type. The model shown is rated ⅓ hp. at 150 r.p.m. in an 18-mile wind. A larger six-bladed one to be manufactured for irrigation pumping is expected to develop 3 hp. in a 15- to 18-mile wind.



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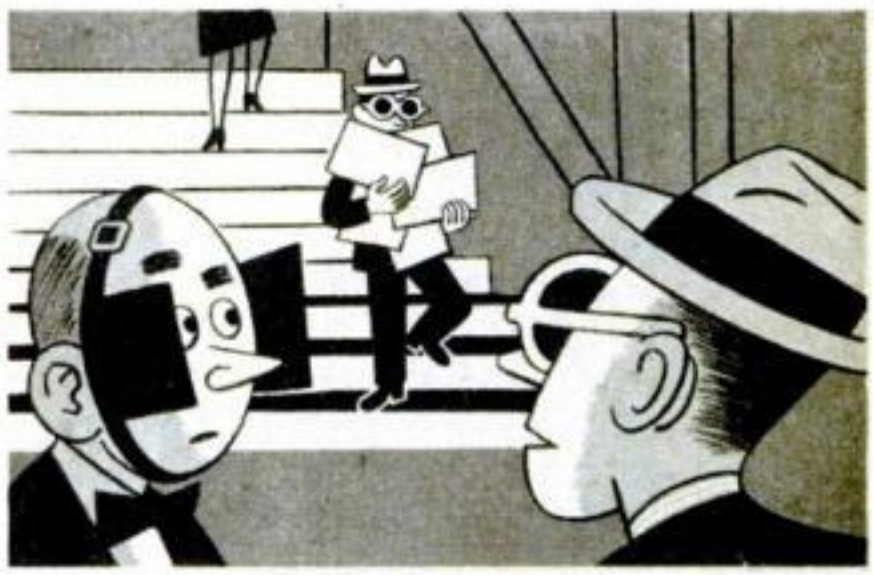
I'd like to see them make

Cartoons by SYD LANDI

Everybody has his own pet idea of some gadget he would like to see in general use. What is YOURS? *Popular Science Monthly* will pay five dollars for every such suggestion that its editors decide to publish.



Front-Door Viewer. Unwelcome callers could be avoided gracefully, thinks R. Auerbach, of New York City, if a television screen recorded their arrival.



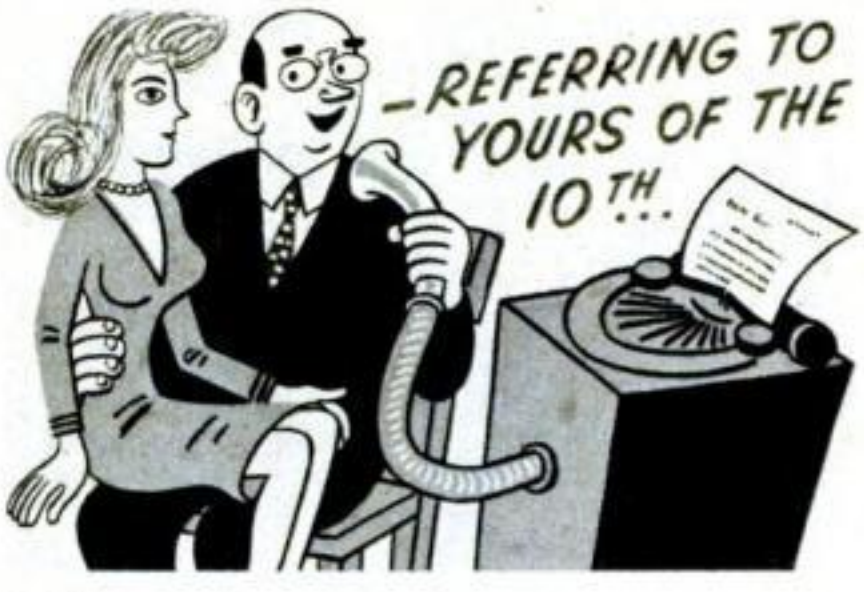
Glowing Stairways. Coat the risers with phosphorescent paint, suggests James Brickel, of Burlington, Vt., and you will eliminate the need for electric lighting.



Car Refrigerator. It would save time and soothe tempers of tourists, declares Sidney R. Pell, of Floydada, Tex., to have cool drinks and food always at hand.



Conversation Cutter. Daniel Shanefield, of South Orange, N. J., proposes a visual means of notifying the long-winded telephoner that someone wants the wire.



Electronic Typewriter. Both boss and secretary might appreciate one, suggests Albert L. Maran, of Endicott, N. Y., that would transcribe automatically.



Adjustable Ironing Board. Mrs. Reis Kash, of Cincinnati, thinks it should have telescoping legs, so both short and tall women could iron comfortably.

lyn, is one of the nation's foremost authorities on fire and fire gases. He points out that three out of four fire deaths result from poisonous fumes rather than flames. Newspapers often refer to "smoke" or "chemicals" as the cause of fatalities.

Dr. Olsen, in association with two other well-known chemists, George E. Ferguson and Dr. Leopold Scheflan, determined to discover what gases, in what quantities, are produced when common materials burn. Under laboratory conditions, they set fire to wood, paper, cotton, wool, silk, rubber, and gasoline, and measured the gases produced.

Monoxide Isn't Alone

As expected, they found that all these materials give off large quantities of carbon dioxide and carbon monoxide. But they also found that the type of rubber compound used to insulate electric wire will produce hydrogen sulphide; that the smoke from wool contains hydrogen sulphide, ammonia, and deadly hydrogen cyanide; and that silk will smolder into prussic acid fumes and ammonia.

Dr. Olsen and his associates also determined that burning cellulose materials, such as wood, paper, and cotton, will produce pyroligneous acid fumes, which attack the mucous membranes. This irritating smoke is comparatively harmless when breathed for a short time. But it can do serious harm if you are trapped and forced to breathe it for several minutes. Such smoke poisoning often leads to pneumonia. It has undoubtedly been a factor in many fire deaths.

The public has learned to have a horror of—and a healthy respect for—carbon monoxide. But what is not well known is that carbon dioxide, not so dangerous itself, greatly increases the danger from toxic gases.

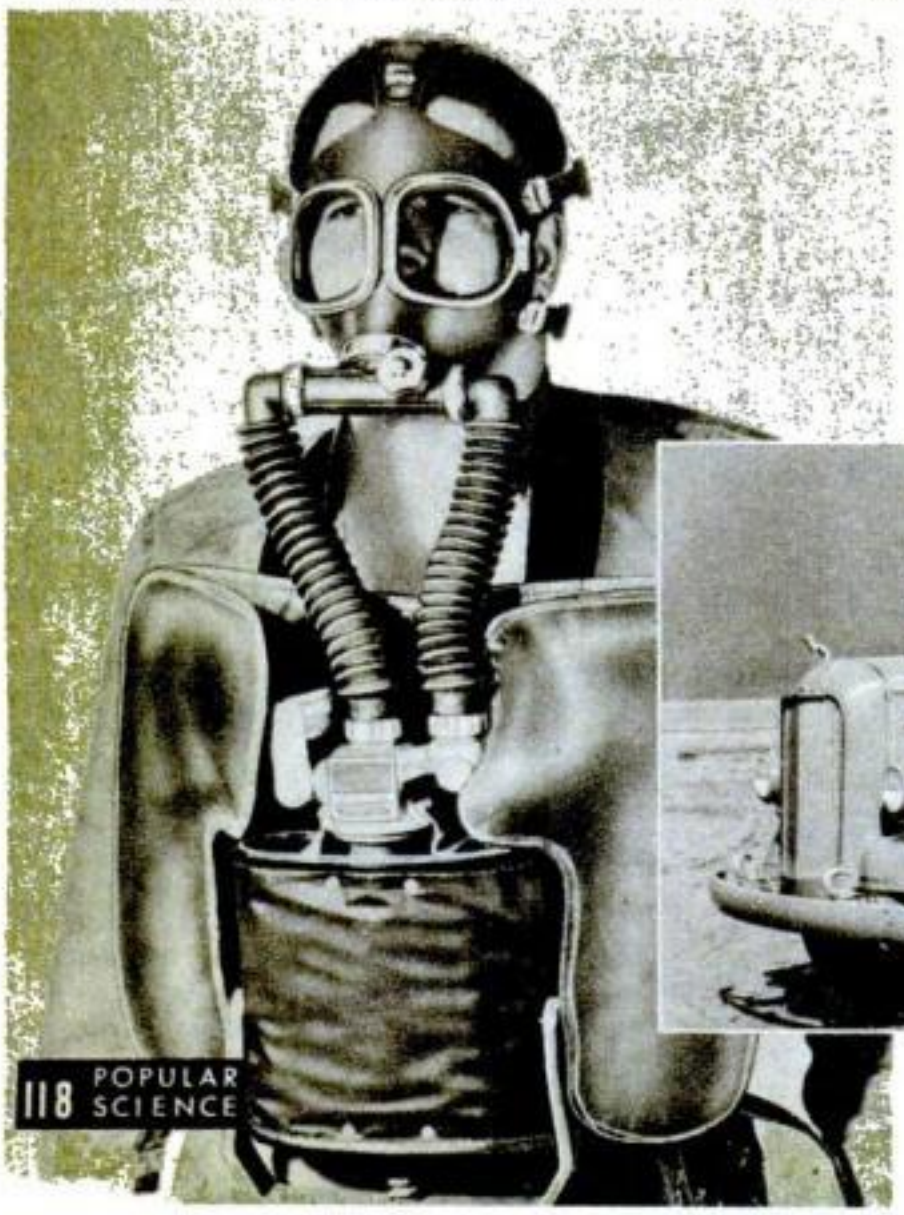
It is carbon dioxide that stimulates breathing. In higher concentrations, it even causes dyspnea, the medical term for panting. Since practically all fires produce both carbon dioxide and carbon monoxide, the speed-up effect of the carbon dioxide on human breathing probably accounts for many deaths from fire fumes when the poison-gas concentration was below the usual danger point.

Unlikely as it may seem, Dr. Olsen's experiments determined that burning gasoline produces less poison gas than any of the other materials he tested.

But it is notoriously quick to catch fire. Gasoline vaporizes easily. Mixed with air, this vapor is so inflammable that the spark from a cat's fur can set it off. The spark does not even have to be near the gasoline. The vapor may drift on a current of air and find an open flame or spark in another room or in the basement. The result is spectacular, violent, costly, and often fatal.

Hazards Aplenty

Even if you don't use gasoline for cleaning, your home contains many "combustibles" that are essential to daily living. The furniture is mostly wood. The structure of the house itself and its trim are frequently made of wood. The walls are papered, probably, and you have quantities of newspapers, magazines, and books. The rugs and draperies are probably wool, and so is



Breathing apparatus at left produces its own oxygen, permits user to go without outside air for an hour. Chemical in replaceable canister generates oxygen, removes carbon dioxide from breath. Alarm rings when canister needs a refill.

Not all America's fire apparatus is as modern as the 750-gallon combination pumper below. One expert estimates that at least 20 percent of our fire-fighting equipment is obsolete.



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much of the upholstery. The closets are full of wool, silk, rayon, and cotton clothing and bedding.

If touched by fire and the flame gets enough oxygen, the wood, paper, cotton, and rayon will burn briskly. Wool and silk are more fire-resistant, but they will produce plenty of deadly gas, including hydrogen cyanide gas, if hot flames lick them for a short time.

Where Fires Start

Obviously, you should guard your home and its contents against "little" fires. Most home fires start from well-known causes. You should check your home for such hazards as a defective chimney or flue, defective electric wiring, faulty furnace or heater, unscreened fireplaces, or inflammable rubbish waiting for the careless match or cigarette.

Other hazards are not so apparent.

Most important of these is spontaneous combustion. Such fires aren't "black magic." Almost any kind of oil or carbon will gradually combine with oxygen in the air. Under the proper conditions of temperature and humidity, this chemical reaction generates enough heat to start a blaze. Spontaneous combustion can start in a heap of old newspapers, the family coal pile, or in painting rags.

An uninsulated hot steampipe is a fire menace you may have overlooked. Passing through a wooden partition, it may gradually char the wood. This carbonized wood, raised to such a comparatively low temperature as 150 degrees Fahrenheit, will burst into flame if atmospheric conditions are right. A hot chimney or stove may produce the same effect.

Big city fire-department records show that electric refrigerators sometimes suddenly stop cooling their contents and start heating their surroundings. The refrigerant, in some makes, is inflammable. Have this home appliance inspected from time to time by an expert.

Dust Is Explosive

Even dust is dangerous while suspended in air, for if it can burn it will explode on contact with an open flame. Flour, sawdust, coal dust, are all hazards. So never toss loose dust in a stove or incinerator.

Oldest fire hazard is the sun itself. Almost everybody has used a magnifying glass to set paper on fire. Similarly, those ornamental bottles on your window shelves may concentrate the fiery rays on a cotton curtain. A bubble in the window glass, a jar full of water, a glass paperweight are all similar hazards.

Another natural fire source that ha lost any of its potency is lightning, wh starts thousands of fires every year, es cially in attics and roof timbers. As wi electric fires, which start sometimes withi the house walls, you may smell smoke fo several days before a real fire breaks out Get a lightning rod, especially if your house stands in an isolated place.

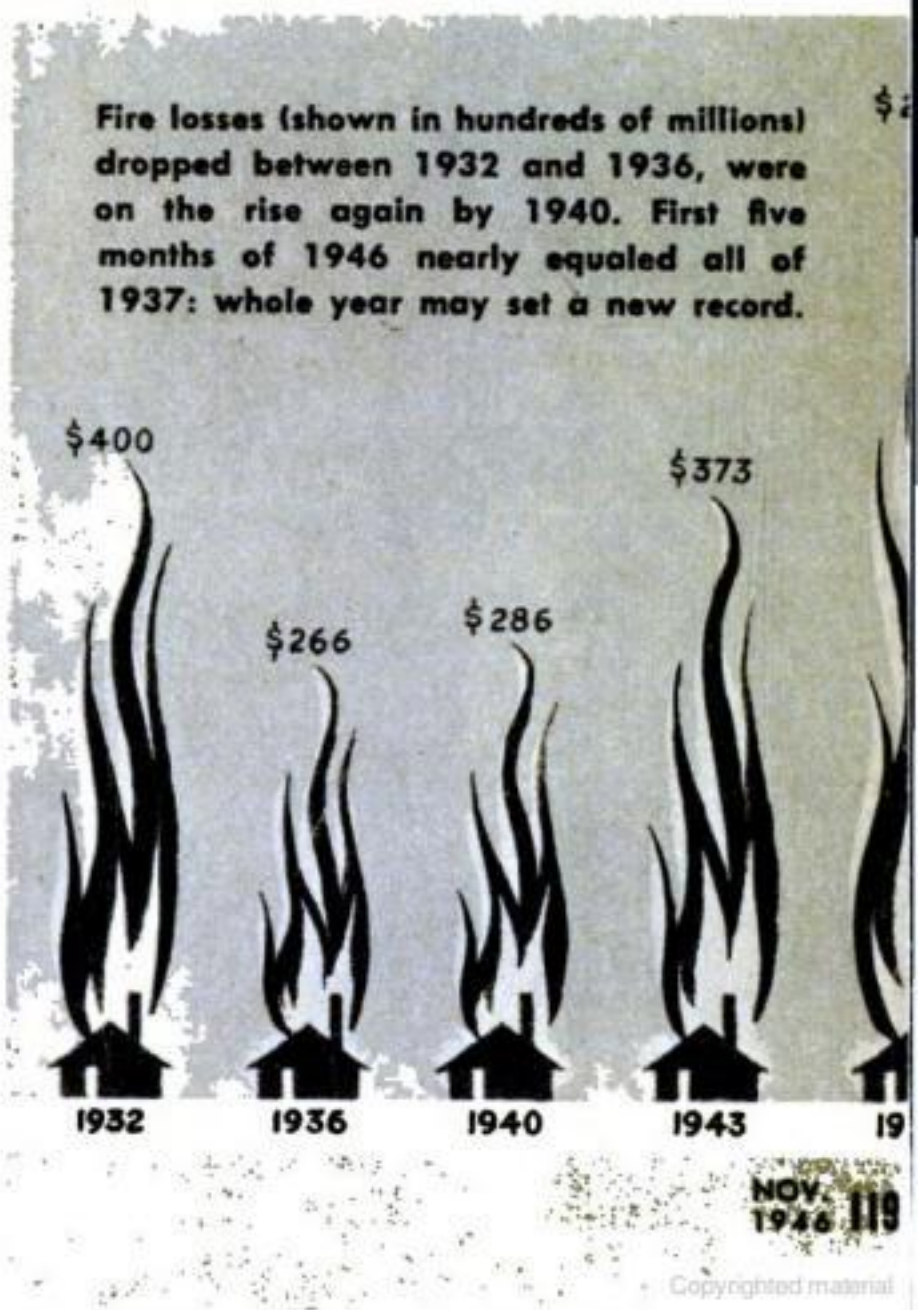
The increasing use of plastics in the home introduces still another fire hazard, and one that has not been fully explored Some plastics are very inflammable. Celluloid, one of the oldest of these synthetic materials, will burn in a flash, as one of Hollywood's most glamorous beauties discovered recently. Her cigarette touched off her artificial fingernails and she suffered painful burns.

Fire Resistance Improved

The newer plastics are more fire-resistant, as a rule. Certain types are even used for electric panelboards. But almost all plastics, if the fire is hot enough, will produce toxic gases.

To save both lives and property, authorities on fire prevention urge keeping fire extinguishers handy, a regular home fire drill, and the systematic elimination of all fire hazards, particularly in the construction of homes.

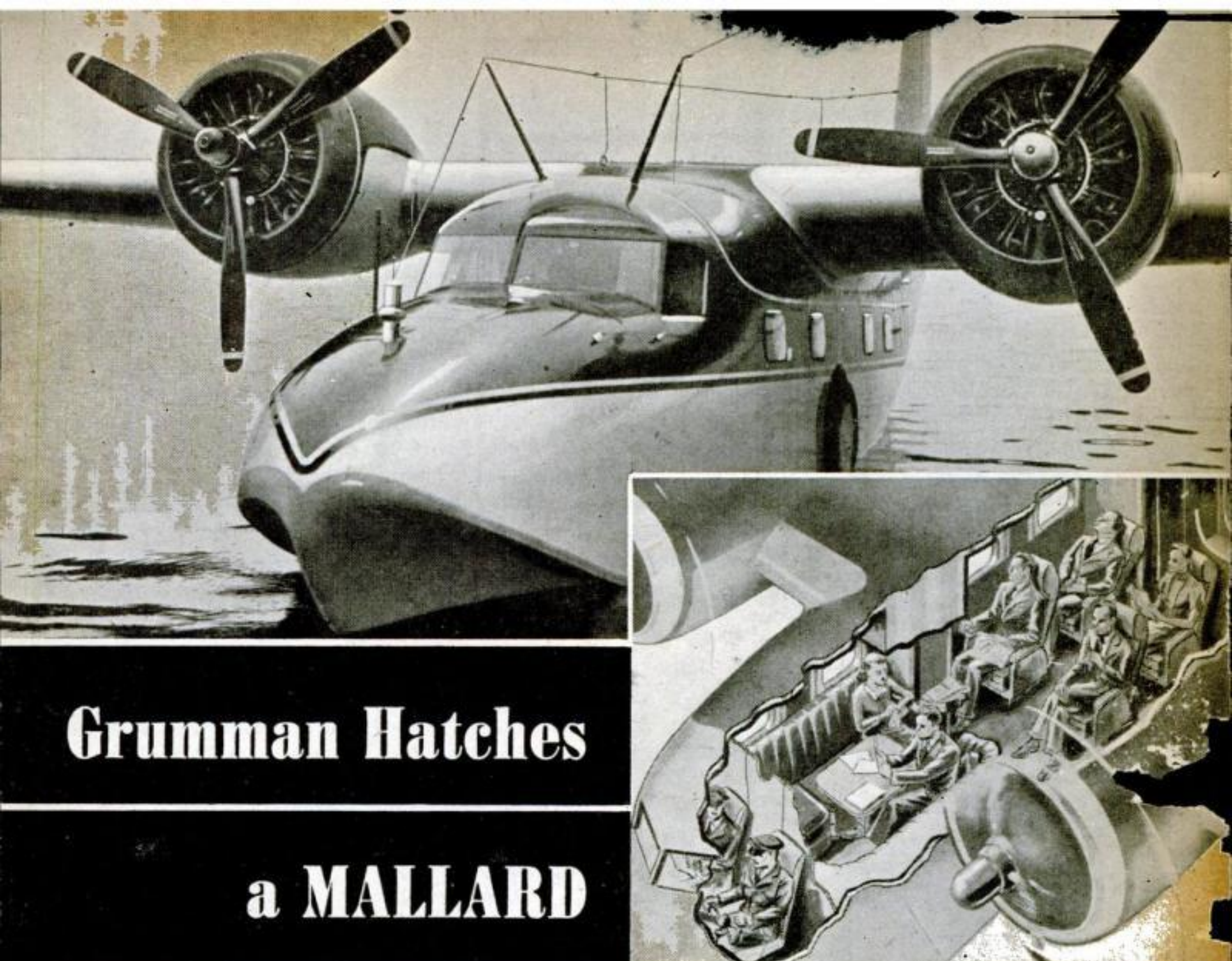
In proportion to the nation's wealth and population, the nation's fire toll has dropped in recent years. But the veteran fireman still sees your home as "a bonfire waiting for the torch."



Fire losses (shown in hundreds of millions) dropped between 1932 and 1936, were on the rise again by 1940. First five months of 1946 nearly equaled all of 1937: whole year may set a new record.

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PEGEE



Grumman Hatches a MALLARD

OUT of Grumman Aircraft's "preserve" at Bethpage, L. I., the Mallard (at left and above) has now risen to fly with the growing U. S. amphibious flock.

The sleek, new airplane, bigger than its predecessors, the Duck, Widgeon and Grey Goose, is currently taking CAA certification tests and company schedules call for full production by early winter. Cruising at 180 m.p.h., the Mallard can carry eight to 10 passengers 600 miles without alighting. In tests it has reached a top speed of 215 m.p.h. Its tentative selling price is $100,000.

The Mallard may serve as a flying station wagon for mining and lumber companies whose holdings are scattered in wildernesses where airfields are uneconomical. In most such areas near-by rivers, lakes or bays offer abundant natural harbors. Markets with perhaps even greater possibilities are the feeder-line and commutation services. The manufacturers expect flocks of this type of plane to be used in metropolitan areas that have both water and land ports. Several air lines serving New York have already placed orders for the amphibian. One company plans to use the Mallard between Manhattan and LaGuardia Airport.

The new craft is driven by two 600-hp. Pratt and Whitney "H" Wasp engines and ground-lands on tricycle gear—unusual for amphibians. The wing spread is 66 feet eight inches; the over-all length, 48 feet four inches. Both the nose, where cargo can be stored, and the hull of the flush-riveted ship are reinforced to withstand the buffeting of water landings and take-offs.

The designer has created a luxurious cabin (inset, above) that can be decorated to suit the customer. A galley is in the rear. The soundproof interior holds four conventional seats and two three-seat lounges, between which a table can be fitted. Ventilating and heating systems are adjustable.

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...A DRONE

CREWLESS, radio-controlled airplanes can now reach almost any point on earth, according to Brig. Gen. William L. Richardson, chief of the Army Air Forces Guided Missiles Division.

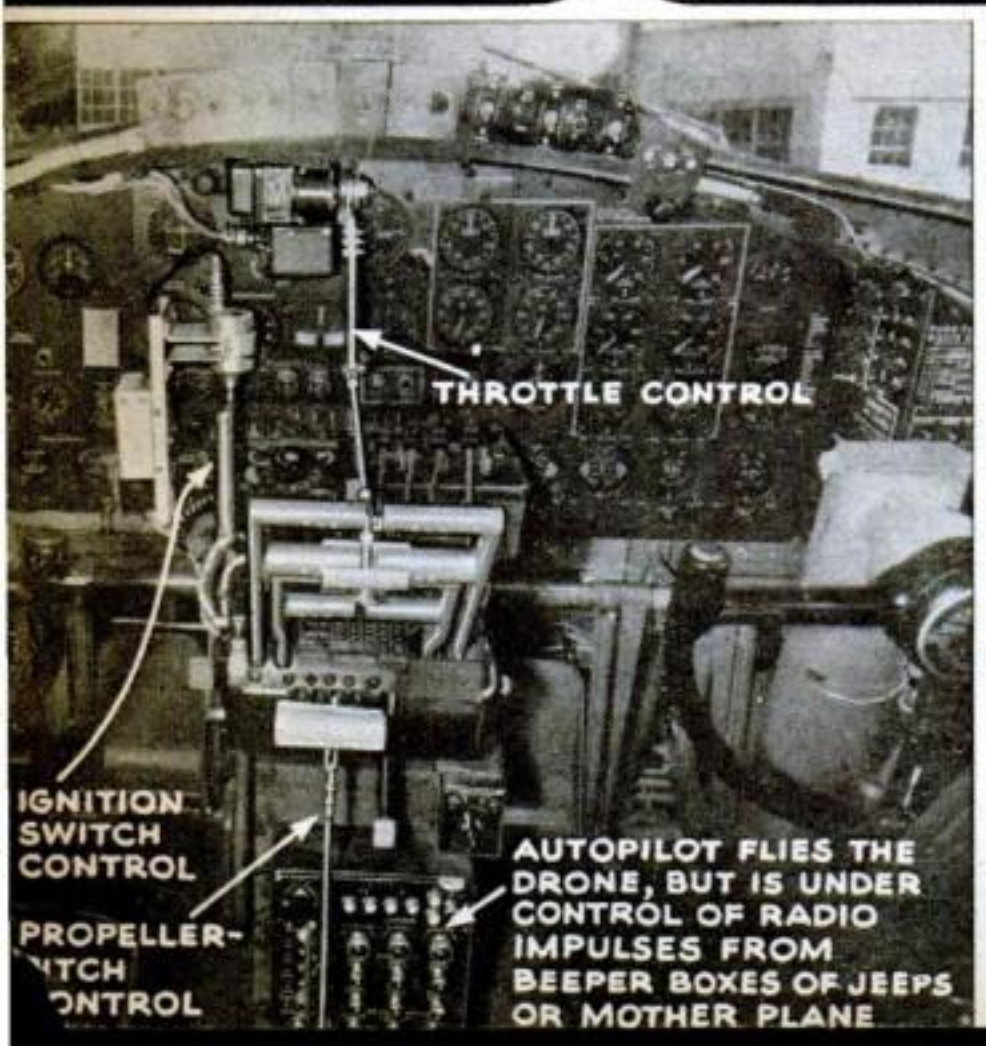
Drones, as the radio-controlled craft are called, have many potentialities, civilian and military. Some day huge mother ships may guide fleets of long-distance, cargo-carrying airplanes across continents and oceans. Long-range drones armed with atomic bombs could be flown by accompanying mother ships to their targets and in for perfect hits. The basic principles of the drone have already been used in flight-testing new airplanes without risk to a test pilot. And early next month, in the first large-formation test of drones under combat conditions, 10 crewless B-17s will weave through flak barrages over Texas as the U. S. Army tries out its newest anti-aircraft equipment.

Through a five-pound control box—nicknamed "Yehudi" (PSM, Dec. '45, p. 93) for the little pilot who isn't there, but more commonly called a "beeper"—today's drone can be made to do virtually anything a piloted plane can do.

It takes three experienced pilots at control boxes to get a drone in the air, fly it and land it. Two control boxes mounted in jeeps guide the drone during take-offs

PILOTLESS DRONE MAKING RADIO-CONTROLLED TAKE-OFF

THIS PILOT CONTROLS RATE OF CLIMB OR DESCENT BY RADIO



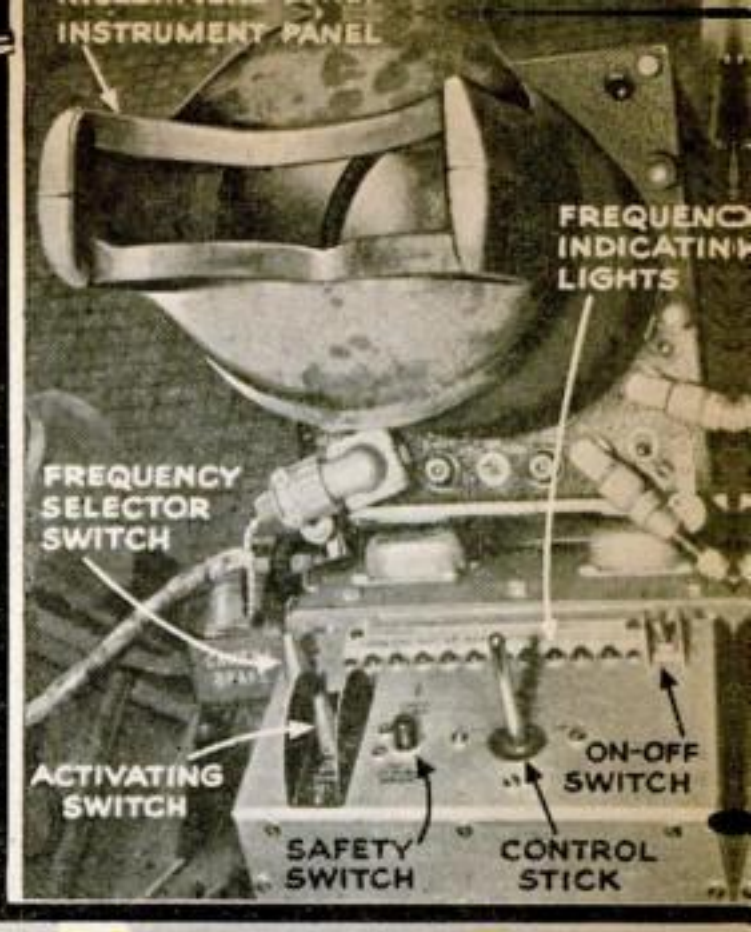
PSM drawings
by STEWART ROUSE

The view of a drone's pilot cabin at left shows the motors that control the ignition, propeller pitch and throttles on impulses from a ground or mother-plane beeper box. The autopilot activates other controls.

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MOTHER SHIP CONTROLS DRONE BY RADIO DURING FLIGHT

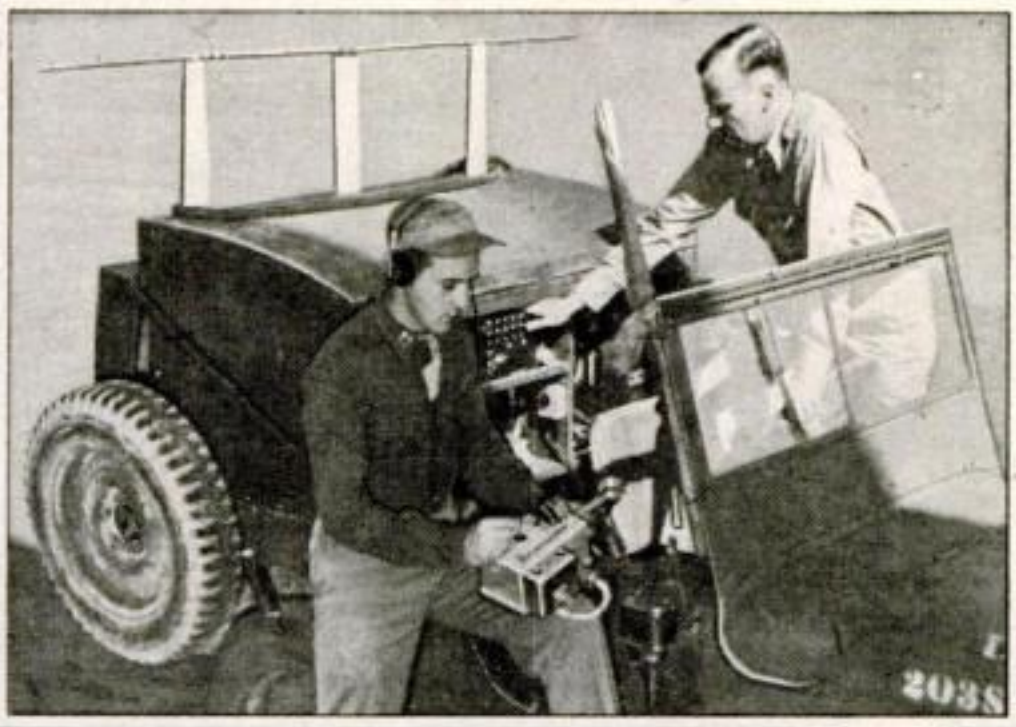




The control box in a mother plane has a television receiver (right) that gives the beeper pilot a view of a drone's instrument panel or a look through its nose.

DRONE MANEUVERING UNDER MOTHER SHIP'S RADIO CONTROL

Drones are launched and landed by crews operating from two jeeps equipped like the one below. One is stationed at the head of the runway, the other one-third of the way along it.



Here a ground beeper pilot, watching a drone's approach, operates the controls to bring it in for a landing.



DRONE LANDING UNDER RADIO CONTROL OF "BEEPER" PILOTS ON GROUND

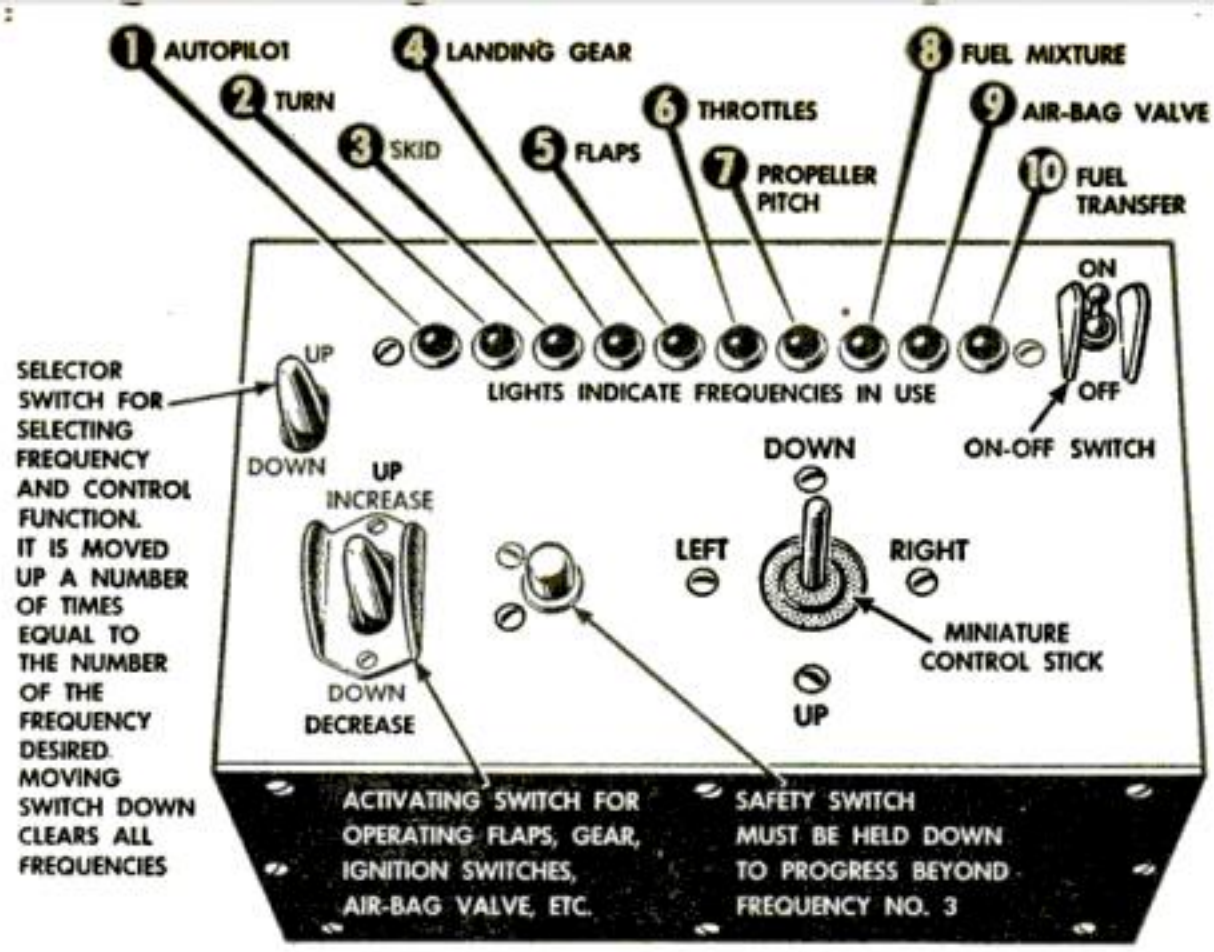
THIS PILOT CONTROLS DIRECTION OF DRONE'S FLIGHT

JEEP WITH RADIO-CONTROL EQUIPMENT

BINOCULARS FOR WATCHING DRONE'S LANDING APPROACH

ROUSE

At right is a diagram of the panel of a mother ship's control box. The row of lights at its top represents the 10 radio frequencies; their functions are indicated. The first three frequencies operate the automatic pilot and, through it, the drone in flight. The remaining seven control motor-driven equipment such as landing gear, throttles and flaps. Frequency No. 1 is generally used in actual flight maneuvers for climbing, turning and gliding, while No. 2 and No. 3 are supplementary flight frequencies. No. 2 permits co-ordinated left or right turns at constant altitude, and No. 3 allows skid turns In using frequencies above No 3, the safety switch in the centc. of the panel must be held in.



and landings. A third, in the nose of a mother ship, maneuvers it in actual flight. Basically all three control boxes are the same. They transmit radio signals on 10 different frequencies to control the drone's flight. With 10 frequencies to control different functions, the pilots at the beeper boxes, by manipulating switches and the miniature control stick, can make the radio plane climb glide or turn. They can operate its flaps, ignition switches, landing gear, throttles, propeller pitch, fuel-mixture control, brakes and fuel-tank transfer.

The functions of the 10 frequencies are not fixed. Through adjustments of the radio brain and the motor-driven control equipment in the drone, they can be altered as needed. In the drones used at Bikini, for example, one of the 10 radio frequencies was used to open and close the valves on bags designed to catch gas samples. Ground beeper pilots seldom have to use all frequencies in drone take-offs and landings.

In take-offs and landings, the control-box jeeps are stationed at the runway, one at its head, the other one-third of the way along it and off to one side. The beeper pilot at the head of the runway controls the direction of the plane, manipulating its rudder to keep it lined up with the runway. He also applies the drone's brakes in landings.

The beeper operator in the second jeep controls the drone's elevators and throttles. On take-offs he regulates the length of run and the initial rate of climb. On landings he sets the glide path and determines the touch-down point.

Once the ground pilots get a drone 400 feet into the air, they relinquish control to a beeper pilot in the mother ship. The operator in the mother ship largely uses frequency No. 1 in maneuvering his charge. He handles the controls of the drone by movements of the miniature control stick on his beeper box. This box sends out his signals to the drone's radio brain. The brain transfers them to a conventional automatic pilot in the cabin of the drone, which in turn moves the pilotless plane's rudder, elevator and ailerons to correspond with the beeper pilot's commands.

To advance or retard a drone's throttles, the selector switch on the control box is pushed forward the correct number of times until it tunes in on the throttle frequency. Thereafter the throttles are activated by pushing the control box's activating switch up to advance or down to retard. An electric motor in the drone's cockpit moves the throttles, and similar motors operate the propeller-pitch controls and the ignition switches.

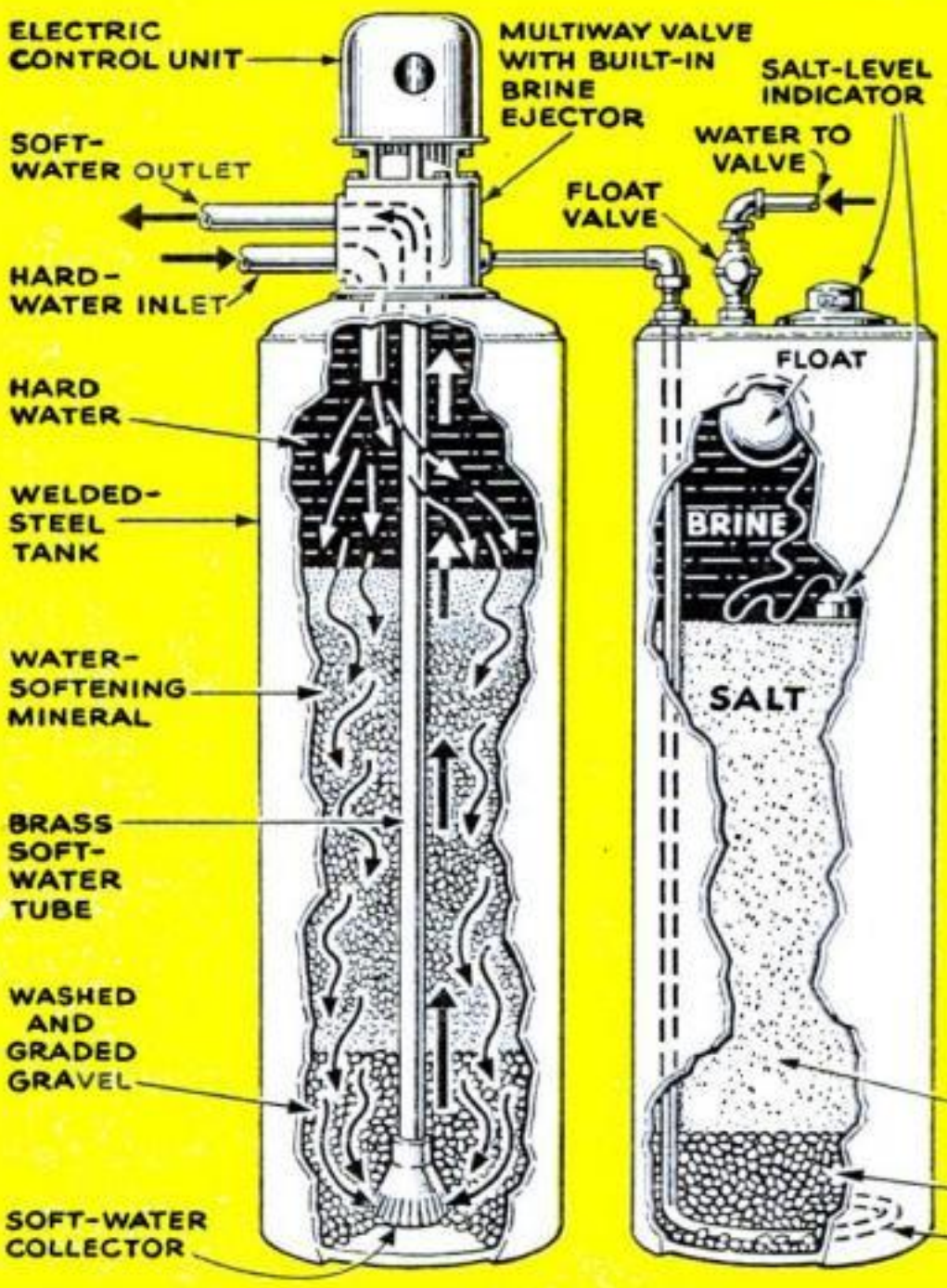
Above the beeper box is a television receiver. By pushing the correct buttons, the beeper pilot can get a television view of the drone's instrument panel or a view through the drone's nose of what lies in its path. In this way, the remote-control pilot can continue to fly the drone even though it has been lost to his sight in clouds.

At present, the remote-control range of a drone is limited to line of sight—if it is within the line of sight it can be controlled. This limits ground operation to about 10 miles and mother-ship control from 35 to 50 miles.

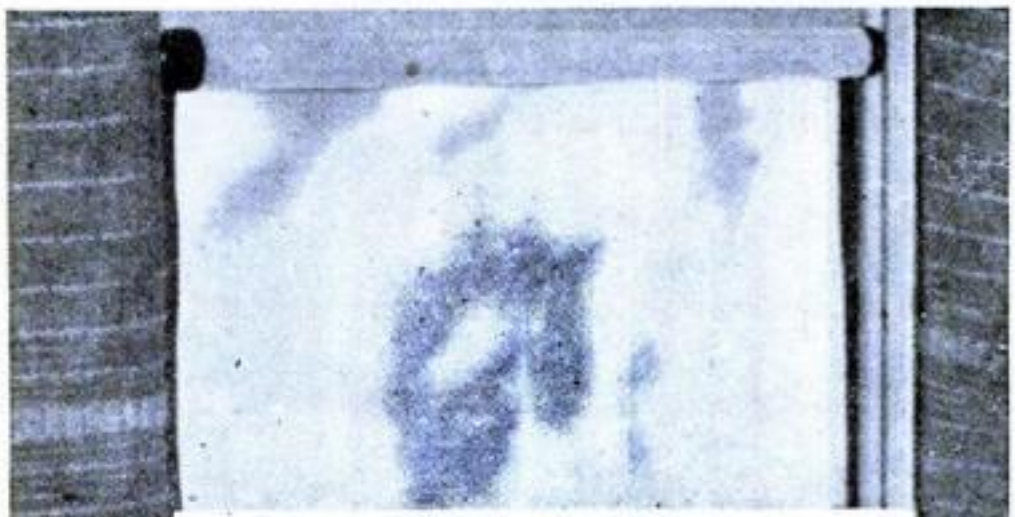
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The clear bottle at right was cleaned by water run through the new Permutit home water softener below.

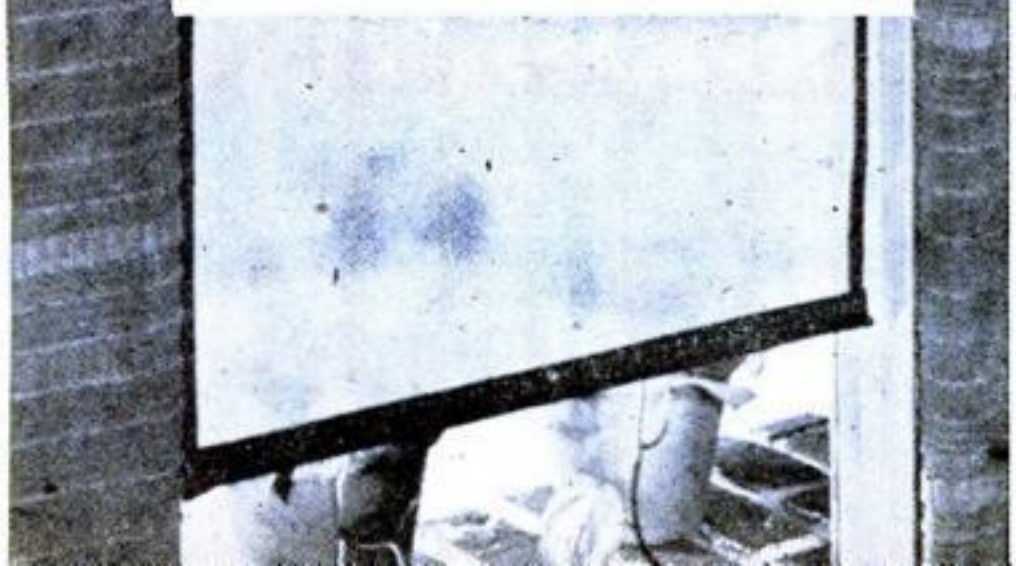




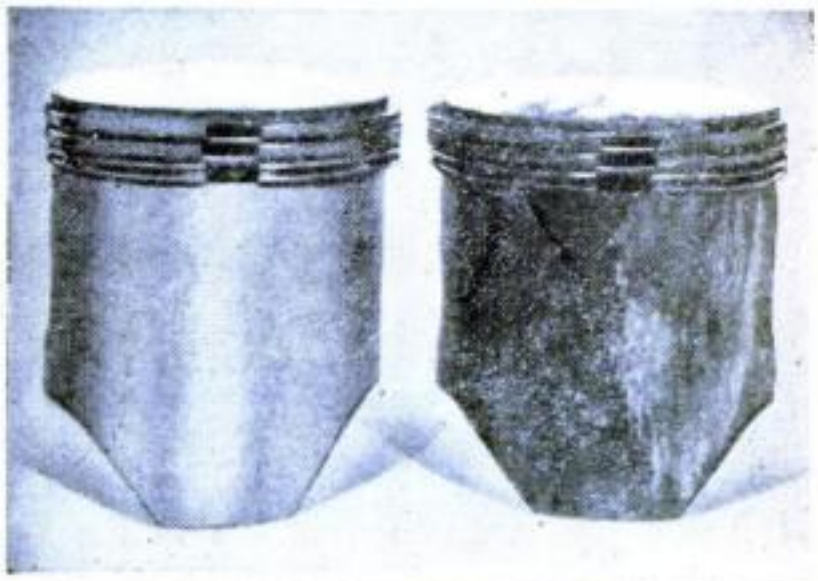
Home Water Softener. Through ruined clothing, corroded pipes and wasted soap, hard water costs the average American family of 4.45 persons up to $100 a year. Now the Permutit Co., which has long serviced industrial plants, has perfected a five-foot home water conditioner using the zeolite softening system diagramed at left.



Light Conditioner. This plastic-mesh Vimlite shade blocks glare yet allows entrance of all light without loss of privacy. Each square of its mesh is a concave lens.

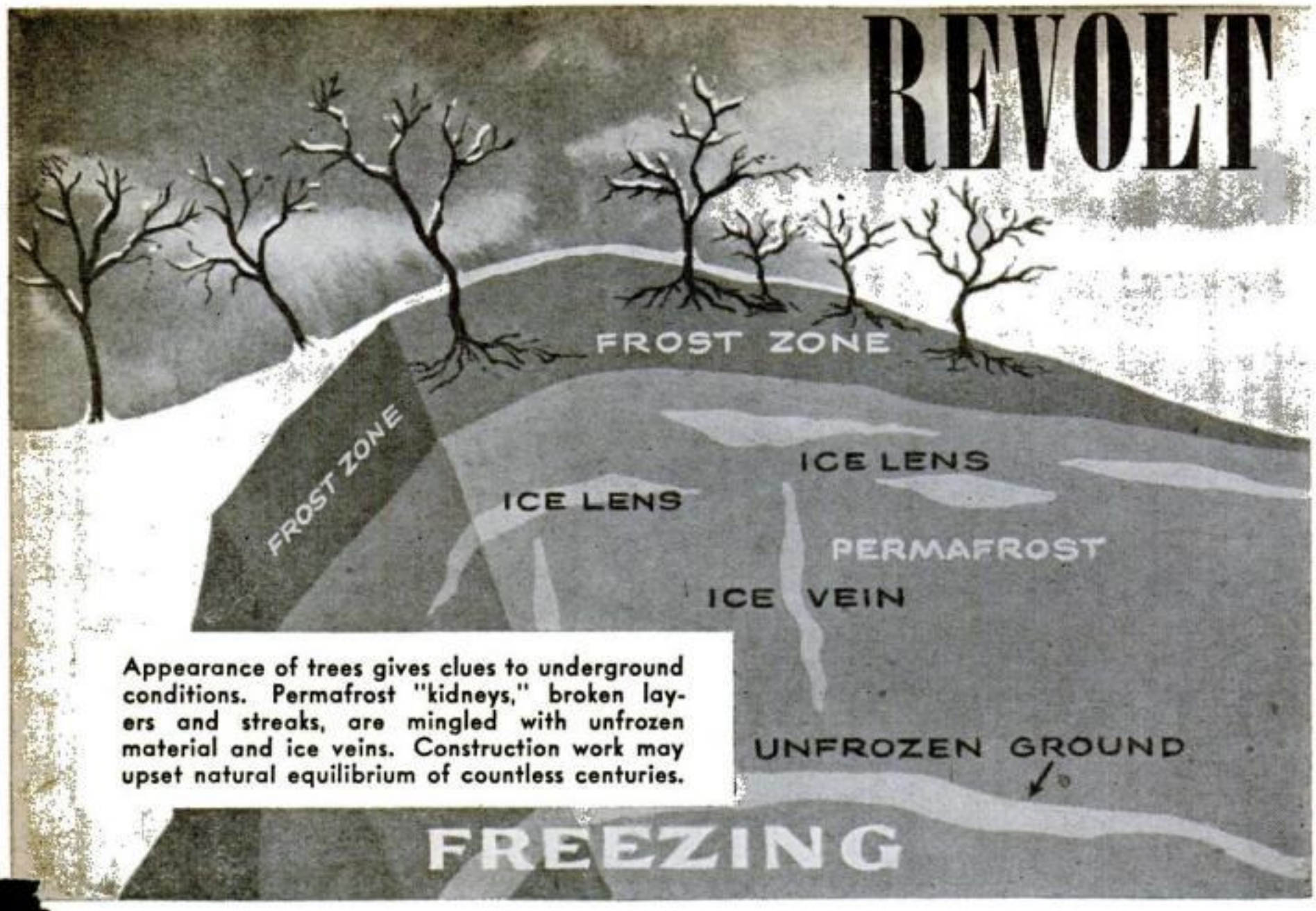


Superior Lubricant. Permalube is a new motor oil war-developed by Standard Oil Co., of Indiana. Engine tests have disclosed that it deposits a minimum of carbon on engine parts, reduces ring sticking, cuts oil consumption and aids cold-weather starting. The left piston, below, was lubricated with Permalube, the right with ordinary oil.



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REVOLT



Appearance of trees gives clues to underground conditions. Permafrost "kidneys," broken layers and streaks, are mingled with unfrozen material and ice veins. Construction work may upset natural equilibrium of countless centuries.

EVERY winter the runway of the Northway Airfield on the Alaskan-Canadian border heaves; every summer it settles again. Concrete floors in the garage and motor-pool buildings crack, doors warp and will not open, and buildings rise and fall a couple of feet as the weather changes.

Northway is only one of hundreds of places that have challenged our construction engineers to whip weather and terrain as international politics and military strategy force us to inch nearer the top of the world. An Army-built field, Northway is located in a treacherous area some 100 miles southeast of Fairbanks.

The restlessness of the earth there results from building on "permafrost," ground that has been frozen for centuries. It rebels when men remove its natural insulation and heat from their buildings penetrates it. Permafrost covers one-fifth of the earth's total land mass, and its thickness varies from several feet to more than 700 feet.

Quelling this revolt of the earth is one of the big jobs confronting the engineers in the arctic—and they're doing it in ingenious ways. Buildings are set on foundations of heavy piling. Piles are sunk deep into the permafrost layer and fitted with "collars" of heavy tar paper wrapped around the upper portion of each pile. Heavy grease, or peat soaked in oil, is placed between the pile and the collar. When the "frost zone" (ground above the permafrost) heaves and settles, only the greased collar moves. The piles remain firm and so does the whole building foundation.

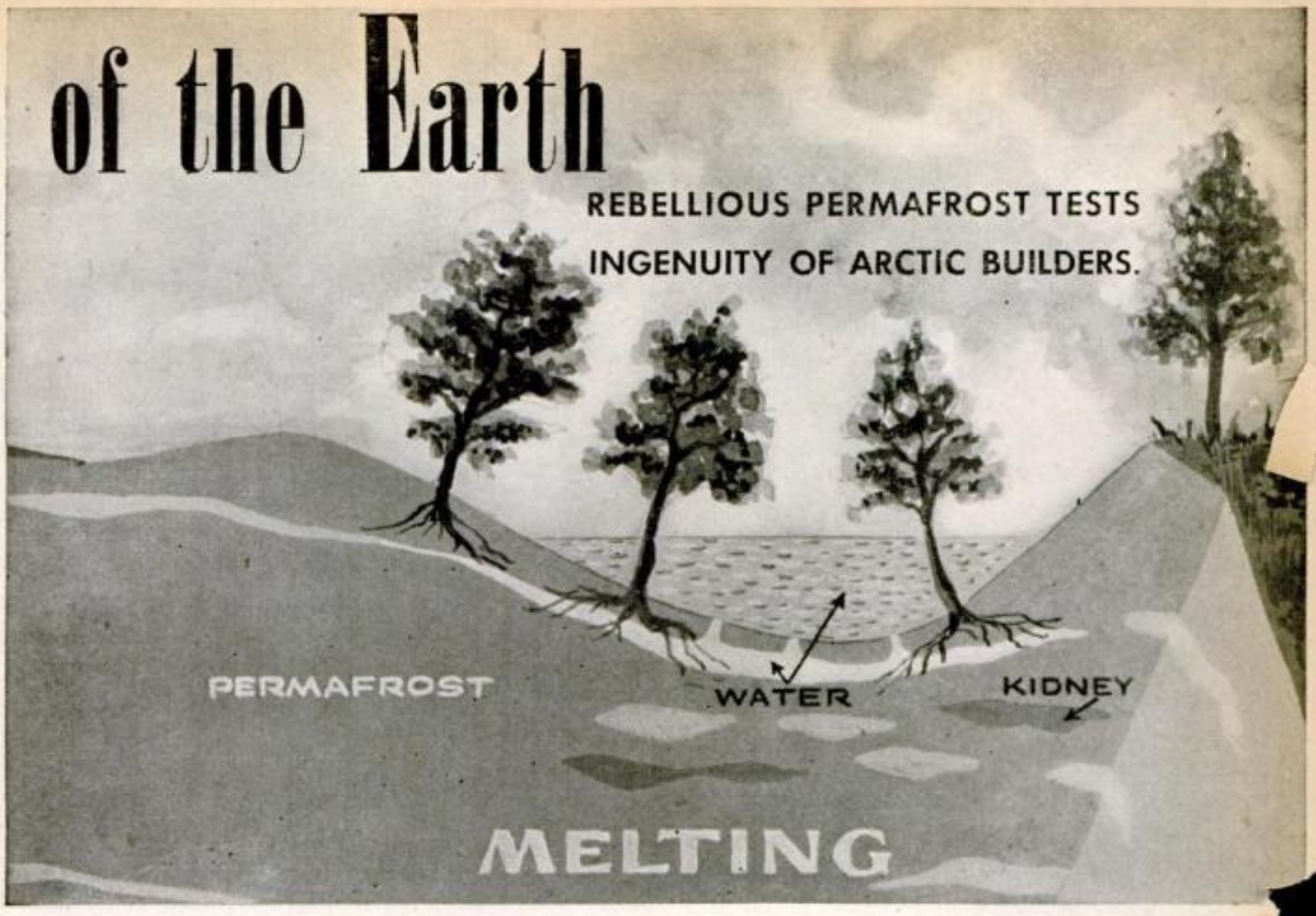
On a vast proving ground near Ladd Field, Fairbanks, Army engineers have laid 40-foot-square sections of 25 different kinds of runways. All the known types and combinations of concrete, asphalt, and gravel are used in the samples. Various bases and subgrades reinforce the surfaces. All are being observed under controlled conditions as they "cure." The samples that survive best will be adopted for our new arctic bases.

Water pipes, telephone and power lines, sewage pipes, and steam lines are buried in the earth in boxlike coverings called utilidors. These were first made of wood planking, but newer constructions are of concrete.

High-pressure steam jets are used for drilling as permafrost defies pneumatic drills. Even steam must concentrate on one spot for an hour and a half to melt a pile hole 14 feet deep and 2½ feet wide in sandy silt soil. Frozen clay takes even longer to thaw.

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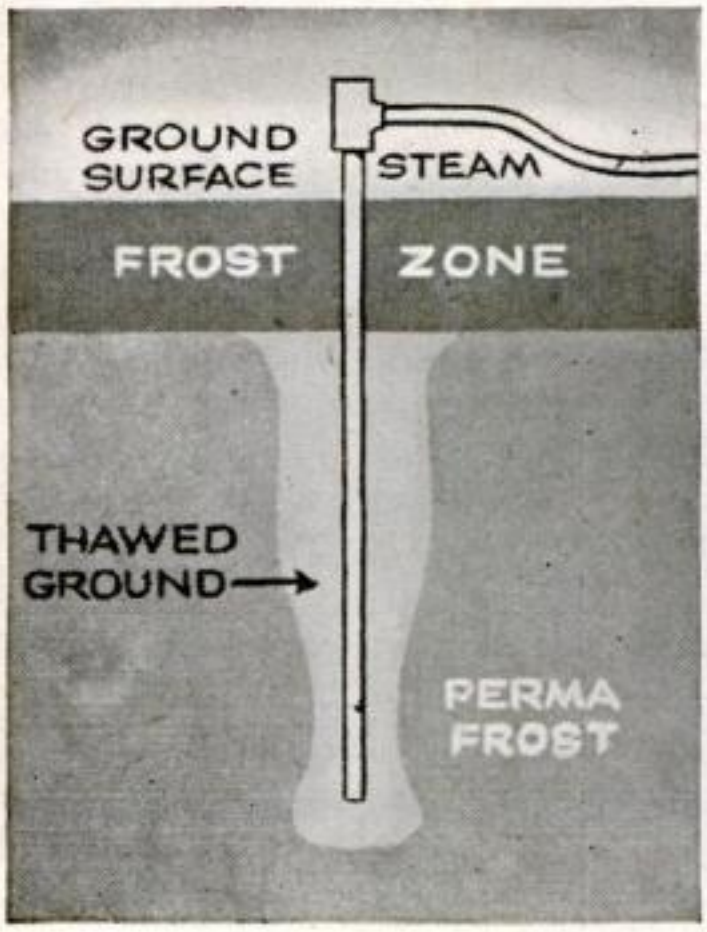
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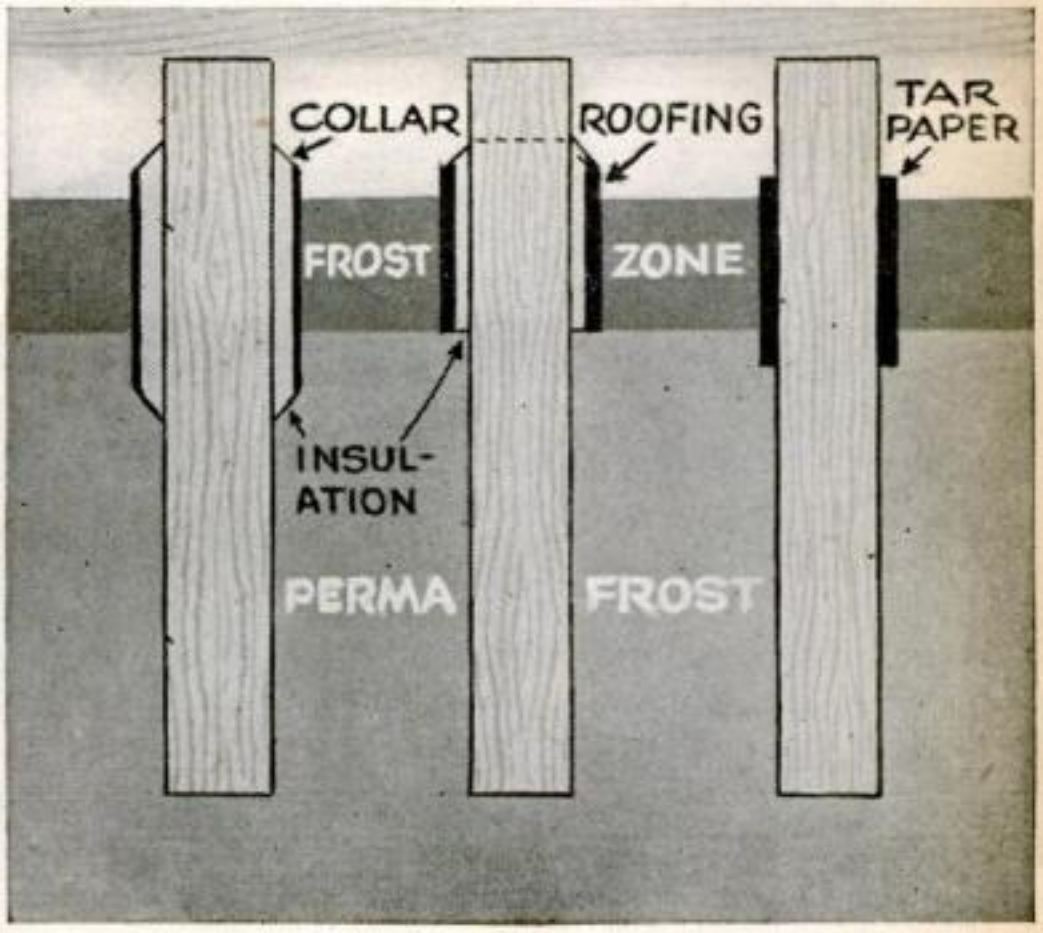
Steam also is enlisted in laying concrete. Lines of perforated pipe crisscross the surface where the concrete is to be poured. During the curing period, tarpaulins cover the cement, and the pipes maintain a temperature of 50 to 60 degrees. If the heat dries the concrete too fast, live steam spra[illegible] and moistens the surface.

Army-developed tricks of maintenance on permafrost areas are as clever as they are novel. Settling of concrete floors is corrected by pumping a soil-cement mixture under

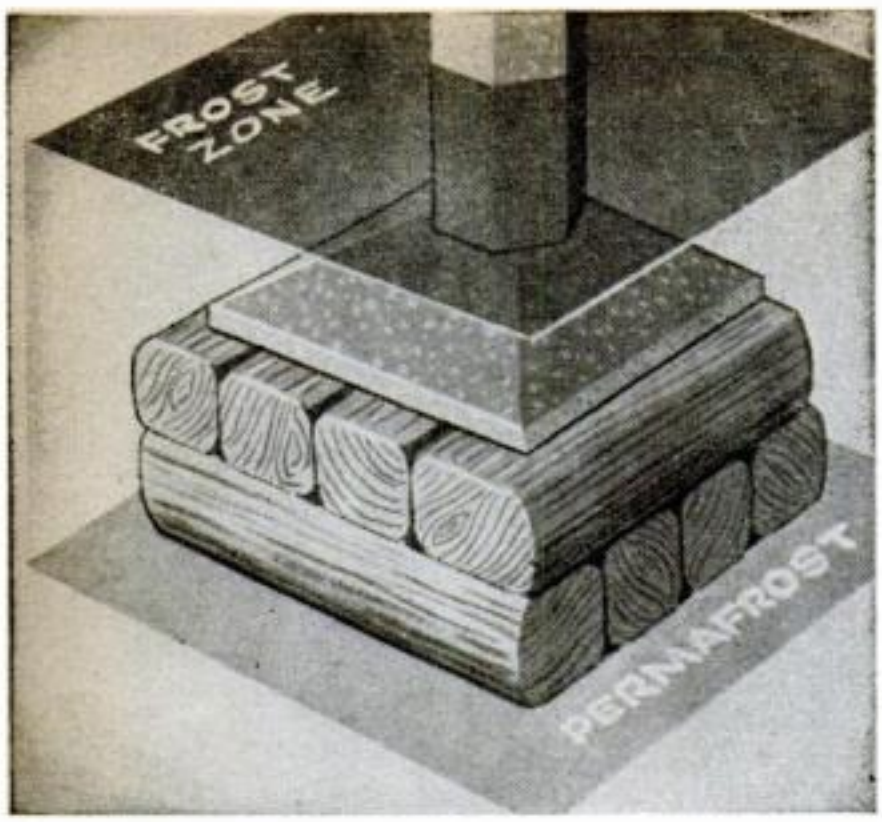
Pressure steam jets are used to prethaw permafrost before piles are driven in.



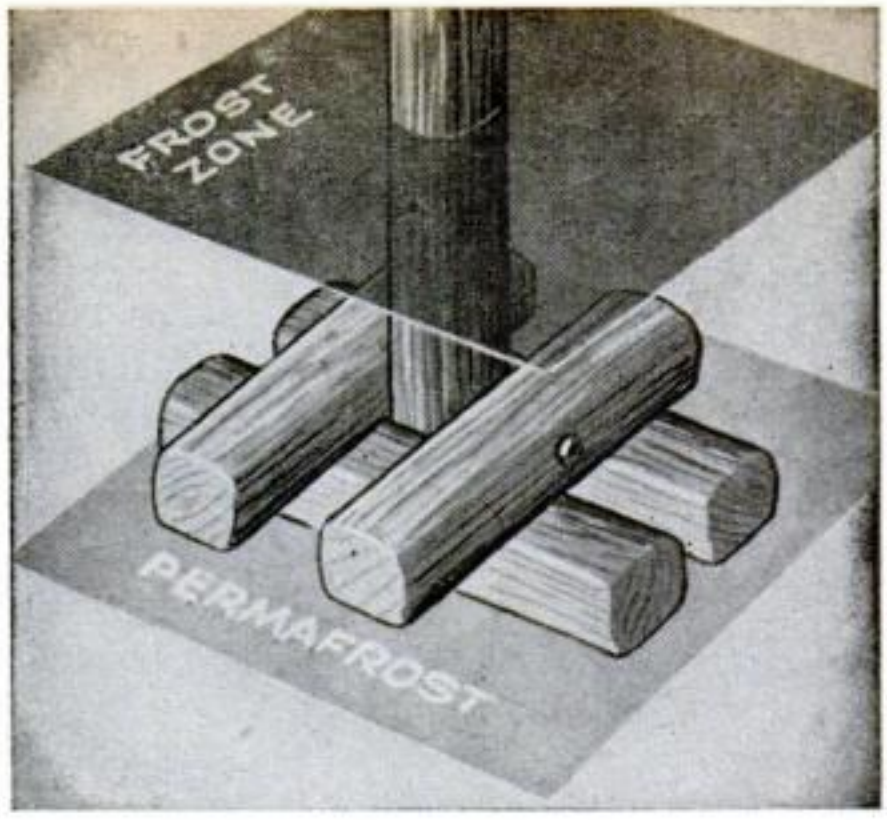
Muffs and collars around piles keep buildings stable. When ground heaves or settles, muff moves, leaving pile motionless.



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Special foundations can foil permafrost. Here piles are set on reinforced concrete foundations, which in turn rest on raft of crisscrossed timbers. Raft is supported by the permafrost table.



In this type, pile is bolted firmly to wood foundation, made of heavy timbers set in ticktacktoe design. Both these types are suitable where there is no ground water and frost zone does not swell.

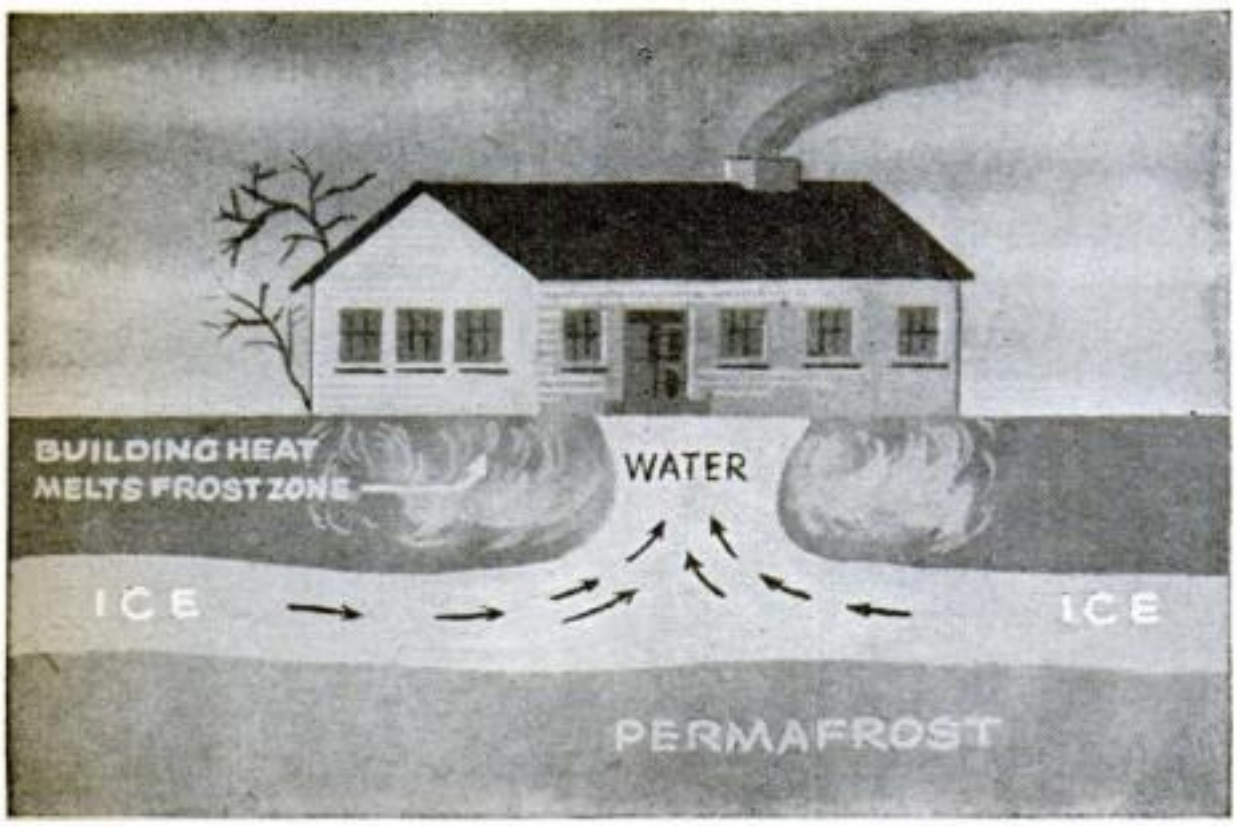
high pressure beneath the floor. Artificial freezing of the earth beneath the floor is done by laying in pipes and pumping cold brine and other chemicals through them.

Surface ice resulting from seepage or awing is kept away from landing strips, ds, and buildings by "inducing." This cks nature into freezing the ice where it will not threaten the construction. "Planes of weakness," or ditches laid at right angles to the direction of the ground water movement, intercept the subsurface flow and bring it to rest in catch basins. This prevents icing on construction sites.

The winter water supply must be stored in huge tanks erected on gravel mats at least five feet thick. Reservoirs and dams can thaw adjacent and underlying ground, causing cave-ins and slides. Water purification and distribution systems for large settlements must be heated to prevent freezing; a well can freeze solid even while it is being drilled.

But after our engineers have conquered permafrost, what? How will this knowledge be used by tomorrow's pioneers? What will attract them to this refrigerated region?

Engineer Richard Finnie, an Alaska veteran, writes in the *Technology Review* that a good many tourists will want to motor up the Alaska Highway and visit the arctic. He also foresees the construction of a tunnel under Bering Strait to link North America and Asia. Still another construction job, likely to be realized in the near future, is the



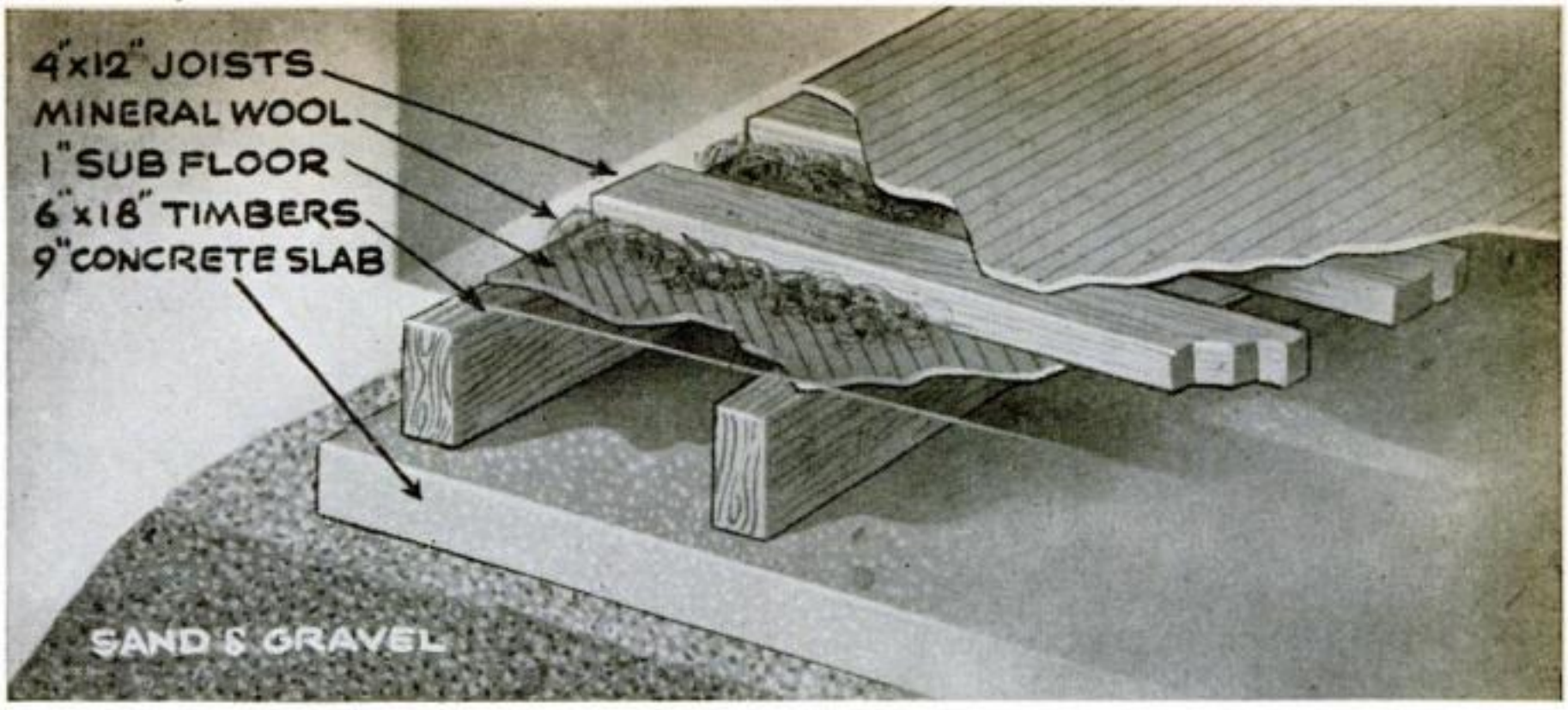
Surface ice may form under heated building with poorly insulated floors and no cold air circulation beneath. To prevent this, engineers use underground channels to maintain continuous water flow, protected from cold air.





At right are ways to prevent surface ice damage to road. Trench allows cold to reach permafrost table, raising its level so that it blocks ground water, which then breaks out through trench to surface where it freezes away from the road.

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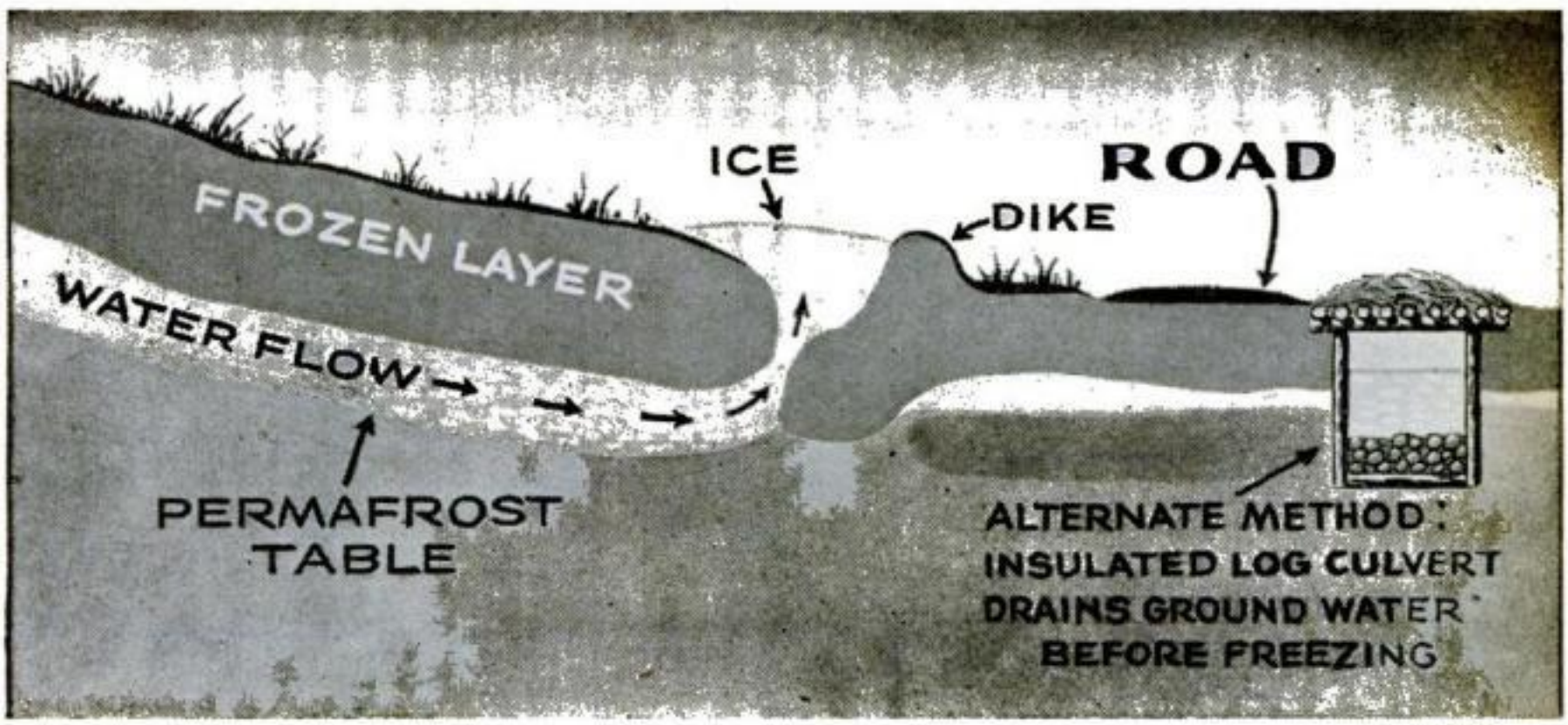
Foundations of heavy buildings, such as hangars, garages or other oversize structures, must rest on a gravel mat extending well beyond the building line. Where buildings are closely grouped the entire area is covered with gravel. The mat must be sloped to drain surface run-off. A concrete foundation slab can rest directly on the gravel, which is unaffected by frost.

building of a railroad northward from Prince George, British Columbia, to the Yukon and Alaska. This route has already been surveyed.

To mining engineers, the need for such transportation projects and for maintaining wartime roads is obvious. The northwest territories have copper, lead, zinc, tungsten, platinum and tantalum in large quantities. Alaska alone has produced $800,000,000 worth of gold, silver, copper, platinum, lead and tin—and more than half of the Alaskan territory still remains to be surveyed topographically and geologically.

In subarctic Canada, the output of pitchblende, silver and gold already exceeds in value the output of furs. Only a modest beginning has been made in the exploitation of these resources. Most of the prospecting to date has been for oil.

Far to the north, at Point Barrow, northernmost Alaskan community, the Navy has an oil reserve in a 3,000-square-mile area of the Endicott Range. Petroleum geologists believe that crude oil from Barrow eventually will be shipped around the Arctic Coast, through the Bering Strait, and on to ports in Southern Alaska and the U. S. West Coast. They also like to speculate on the prospects of laying a pipeline from Point Barrow to Fairbanks, where a refinery could be built. This would eliminate the long haul of crude to refineries far to the south and the reshipment of refined products back to Alaskan industries and military bases.

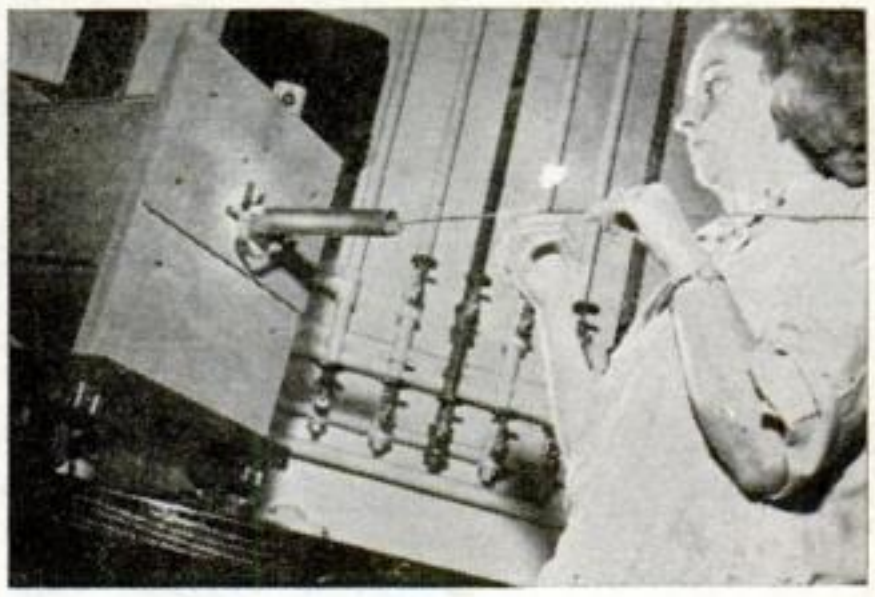


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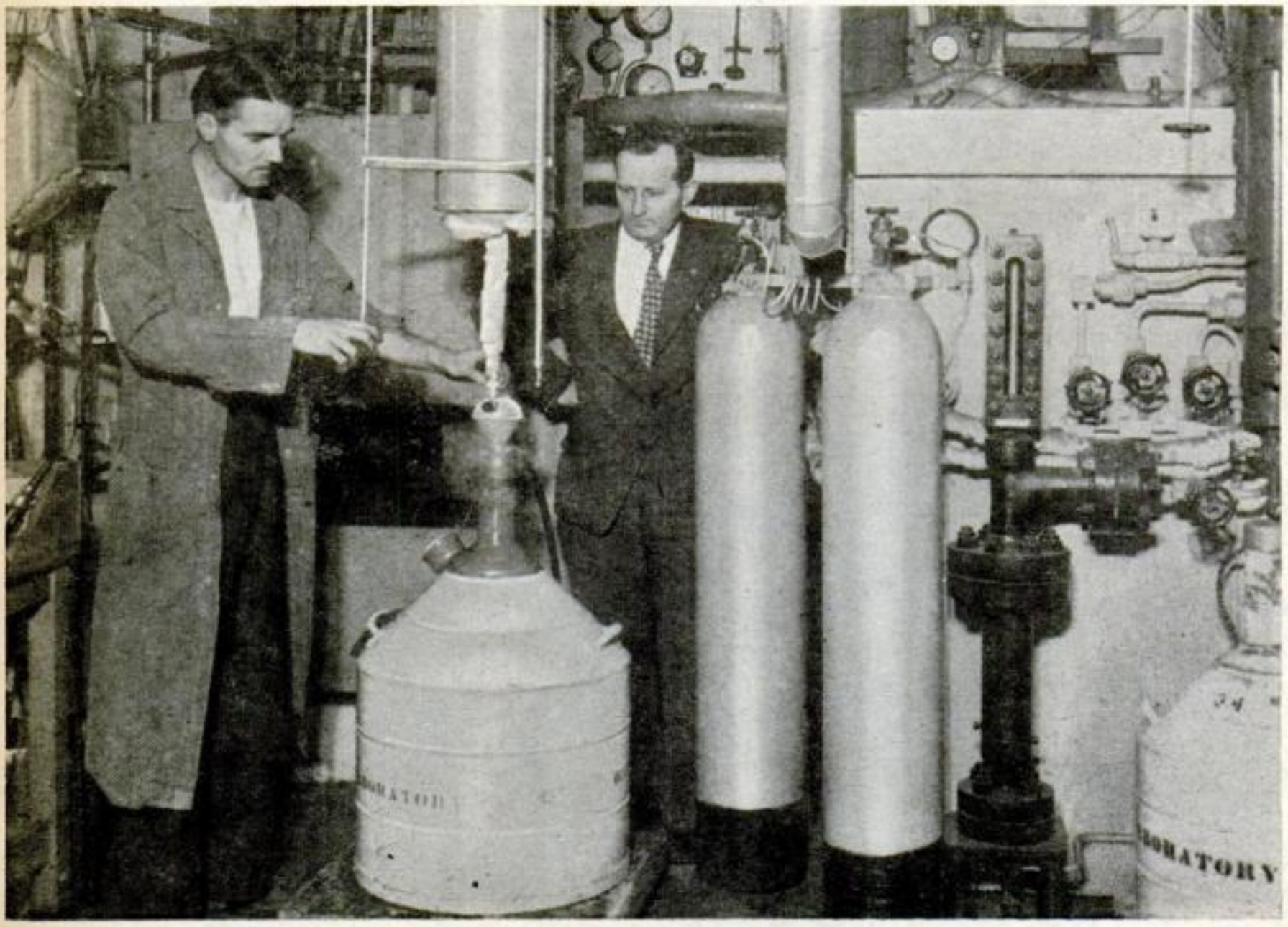
Electric Probe. Foreign metallic objects in the body can be found quickly and exactly with the Berman Locator (left), reports the General Electric X-Ray Corp., of Chicago. A winding creates an alternating magnetic field about the probe. Near a metallic object, changes occur in this field and are picked up by a secondary winding. This creates an audible signal, increasing in pitch as the foreign body is approached.

MARCH OF SCIENCE



Baking Phosphors for Better Lamps. Phosphors that turn invisible rays into light inside a fluorescent tube are made more efficient by baking, according to Westinghouse Electric Corp. Above, platinum boats loaded with chemicals are put in 2,700° F. electric oven to cook.

From −449° to +4,350° F. This range of temperatures available at Ohio State's Cryogenic Laboratory was used on secret Manhattan Project work. Now it will help study of nuclear moments, metallic structures, superconductivity and chemical thermodynamics. Soon equipment will chill to only .001 of a degree above absolute zero (−459.6° F.). Below, liquid air is drawn from apparatus at −308° F.



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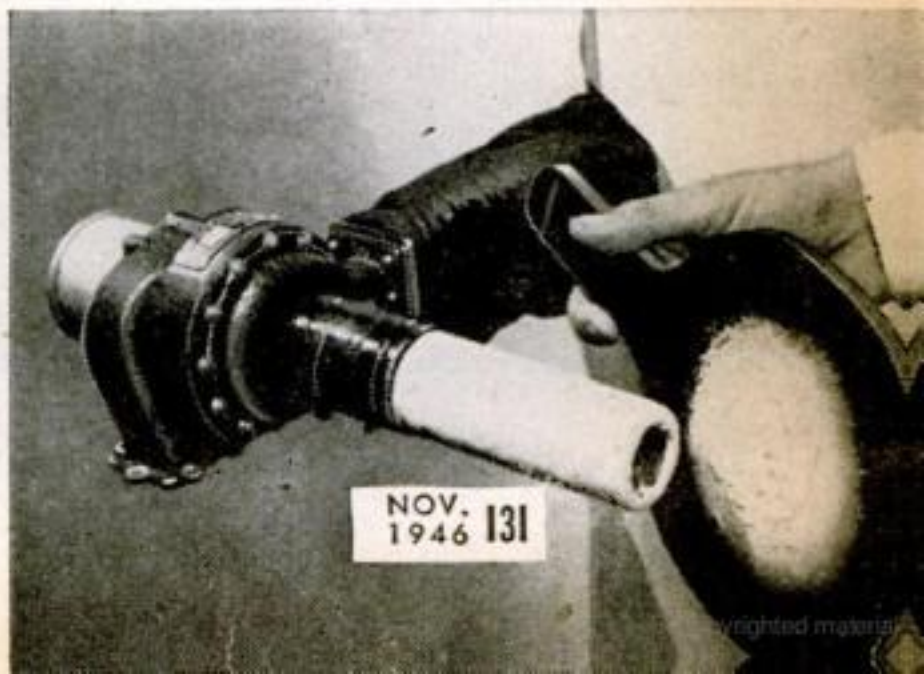
WHAT'S NEW in AVIATION

NEWEST NAVAL SCOUT. The XOSE-1, a catapult-launched plane built by Edo Aircraft, is the Navy's newest scout. Powered by a Ranger 12-cylinder, 550-hp., air-cooled engine, it flies at more than 200 m.p.h. and has a range exceeding 1,000 miles.

U-BOAT KITE. The contraption below is a German rotary kite now being studied by the U.S. Air Forces. It is engineless, weighs 180 lbs. and folds into a compact bundle. Towed by U-boats, it carried an observation pilot, who descended by 'chute.



PRESSURE TEST AIDS. In the atmosphere chamber at left the AiResearch Mfg. Co. tests plane-cabin pressurizing equipment at simulated altitudes up to 70,000 feet. Technicians inside "ascend" within limits of human safety to make adjustments. Another AiResearch pressure implement is the midget air-expansion turbine below. Compressed air enters at about 150° F. and leaves at −15°—cold enough to frost the exit pipe and anything held in front of it.





This panel of drawings reproduces climactic scenes from Hayden Planetarium's sky drama depicting five catastrophes that could wipe out the world. Above, the sun is shown as it explodes into a new star, vaporizing the earth.

In this scene the sun's energy — 35,000,000° F. at its core — has faded and its body is growing cold. Snow [illegible] a frozen, dead earth. Unless the sun finds some [illegible] replenish its energy it is doomed to burn out.

Here an errant star collides with the sun, a third possible way out for the earth. With it would go the other planets: Mercury, Venus, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto, plus the satellites.

Then, one of those celestial nomads, comets, whose existence in the solar family poses a puzzle for astronomers, could crash the earth. Science thinks it unlikely.

Finally, the earth's gravity could lure the moon close enough to explode and loose meteors to bombard us at speeds up to 45 miles a second.

MACHINES

Intricate mechanisms at New York Planetarium show how celestial forces could burn, blast or freeze the world.

By HARRY SAMUELS

PSM Photos by ROBERT F. SMITH

THREE times a day in five spectacular ways the earth "dies" in the Hayden Planetarium in New York.

First performed in 1939, the Planetarium's sky drama was shut down by the war in 1941 and was not resumed until recently. The new "End of the World" show is considerably more vivid than its prewar predecessor because of added startling effects and more authentic background material worked out by the Planetarium technical and scientific staffs. The pictures and captions on the accompanying pages explain how these effects are obtained.

Scientists and others—mostly others—have predicted a possible end to the world in the near future as a result of chain reactions set off by the use of atomic energy.

INGENIOUS LIGHTING EQUIPMENT

One of 12 identical projectors is shown below with slide in position to aid the others in giving the Planetarium's skyline a heavy coating of snow for the "cooling sun" episode. The 12 projectors are set in banks of six. Each bank has its own light source. Each lantern covers 1/12 of the snow scene.



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that "Destroy" the Earth

The varieties of cosmic destruction depicted in the Planetarium show are, however, many millions of years distant by estimates of most astronomers.

The Planetarium audience, seated under a huge dome, is transported through time and space to the center of Central Park in New York on a day billions of years in the future.

The earth comes to its end the first time as the result of the misbehavior of the sun. The sun bursts into a nova, or new star, something that more than 10 other self-illuminated, gigantic heavenly bodies do each year (PSM, July '46, p. 108). The sudden, cataclysmic flood of heat and energy generated by the blast shrivels the earth to death.

Next, the Planetarium onlookers watch the other, but equally final, extreme—the eventual cooling of the sun to a degree where our globe becomes bleak and frozen and can no longer sustain life.

Gordon A. Atwater, Planetarium chairman, says this cooling of the sun is an almost certain eventuality unless it has some unknown and inexhaustible means of renewing its energy.

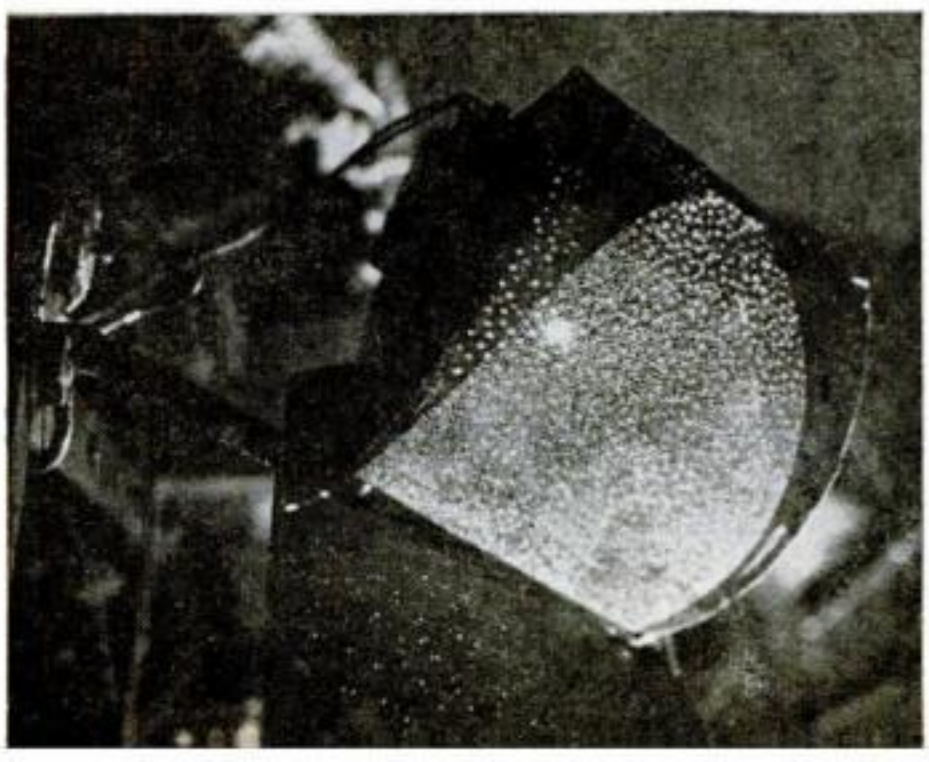
In the third preview of doom, the earth and all the other planets of our solar system

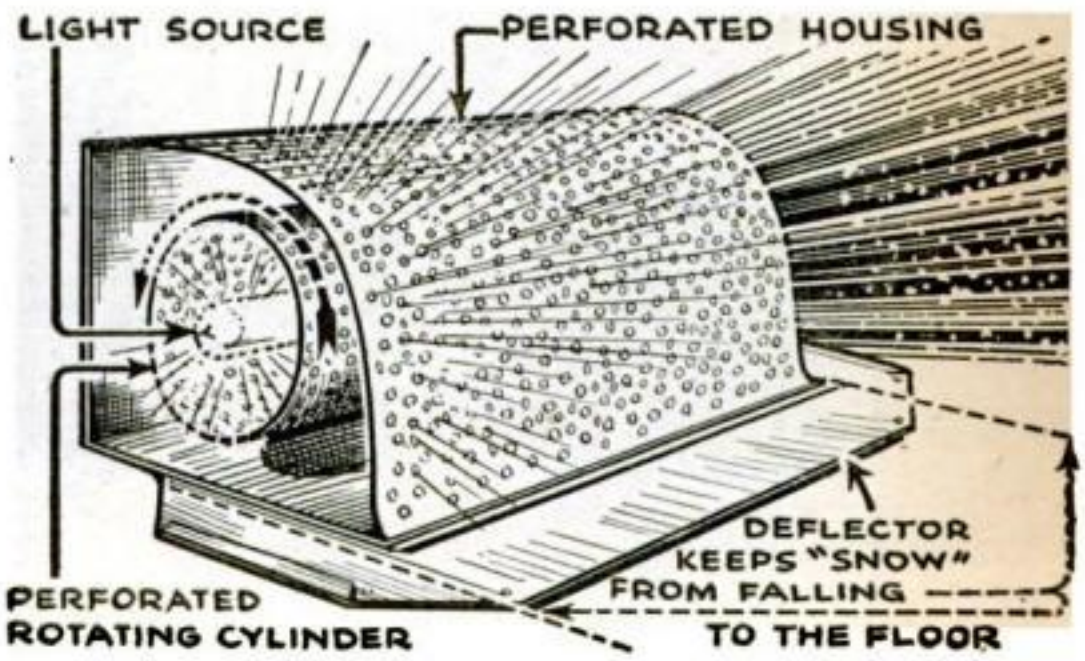


When the moon explodes and sets the earth on fire, 12 projectors (top row, above) throw the fire scene around the base of the sky. Fred Raiser, who designed all special effects, is adjusting the Lucite disks, which are blobbed with transparent cement and when rotated cause the flames to flicker.

GIVES "END OF THE WORLD" DRAMA ITS TERRIFYING REALISM

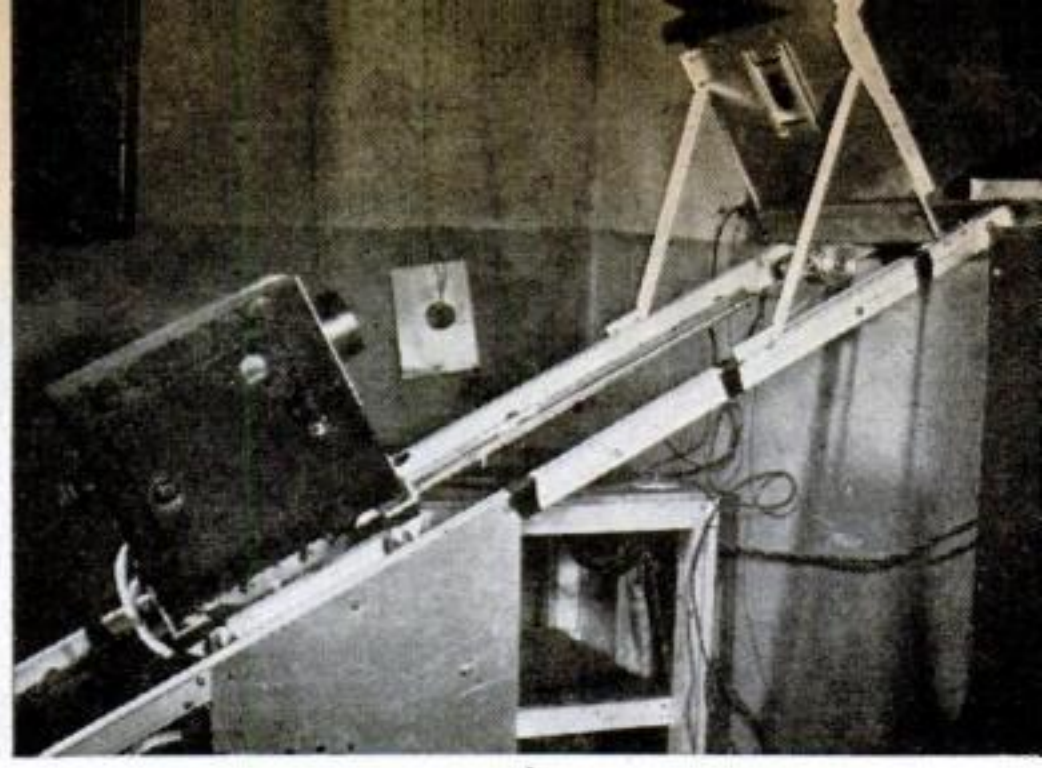
In the scene in which the sun loses its heat and the earth grows cold, the audience in the Planetarium seems to be in the middle of a real blizzard. Below is one of six projectors that create this illusion. The lantern consists of a light source inside a revolving cylinder whose surface is perforated with tiny holes (see diagram at right below). The projector's housing is also pierced. Light passing through the two sets of holes is thrown on the stage sky in a spotted pattern. As the cylinder turns the spots move and give the impression of a snowfall. This is one of the show's most startling scenes.



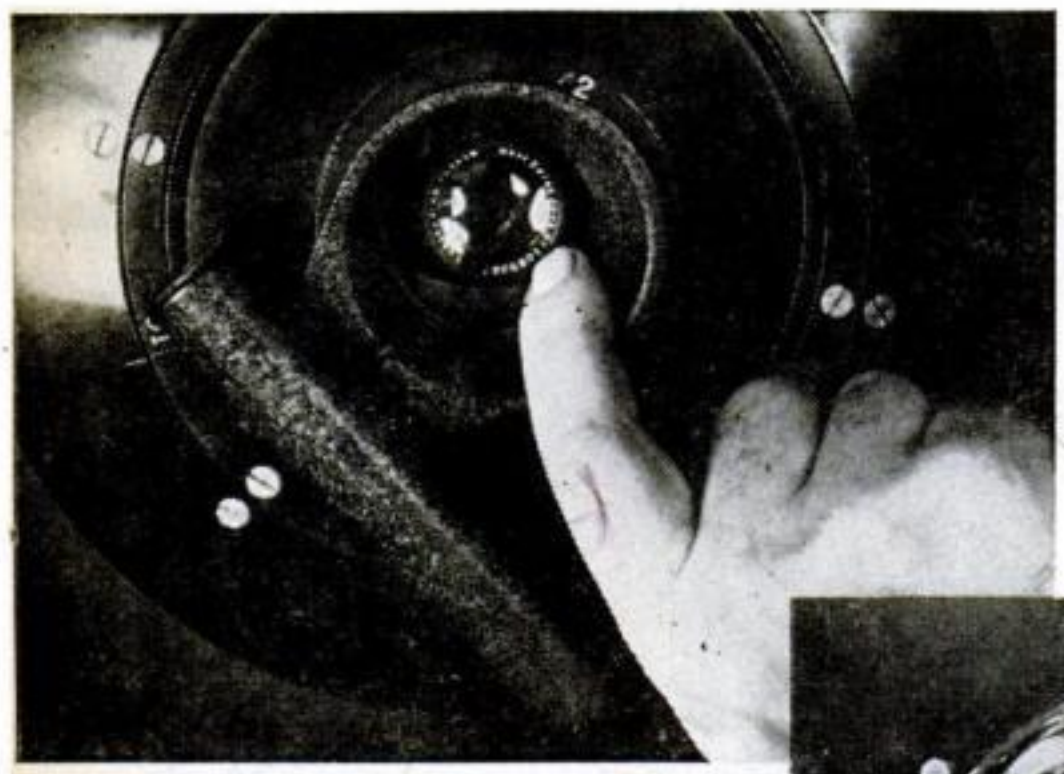


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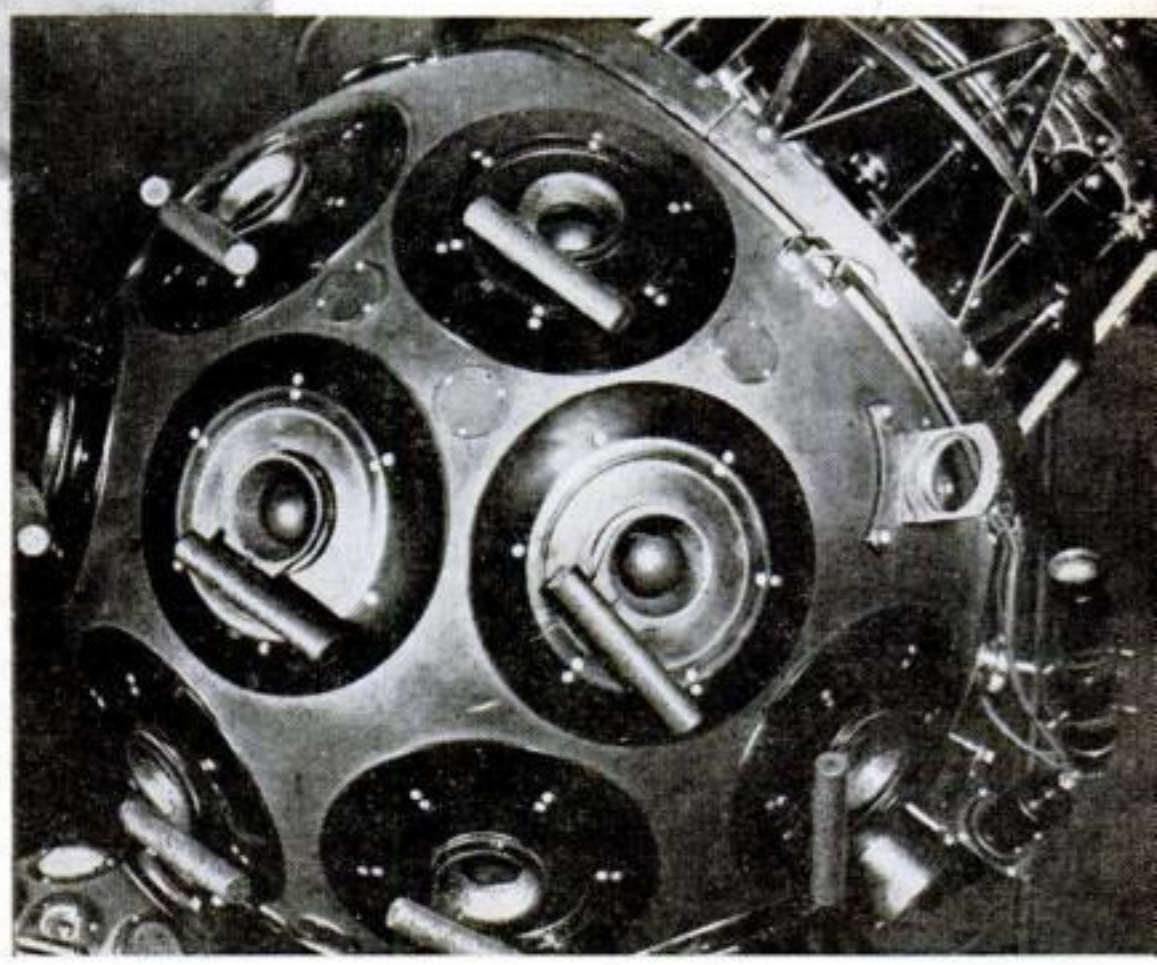




The moon attains astounding size as it approaches the earth (left). This is done with a carbon arc light, a photographic transparency of the moon, and a pinhole (above). Light from the arc travels through the transparency and the image of the moon is projected through the pinhole onto the Planetarium's hemispherical roof. As a motor-driven spool pulls the arc lamp closer to the transparency, the moon's image grows bigger and bigger. A pinhole is used because a glass lens would not hold sharp focus as the arc lamp nears the transparency.

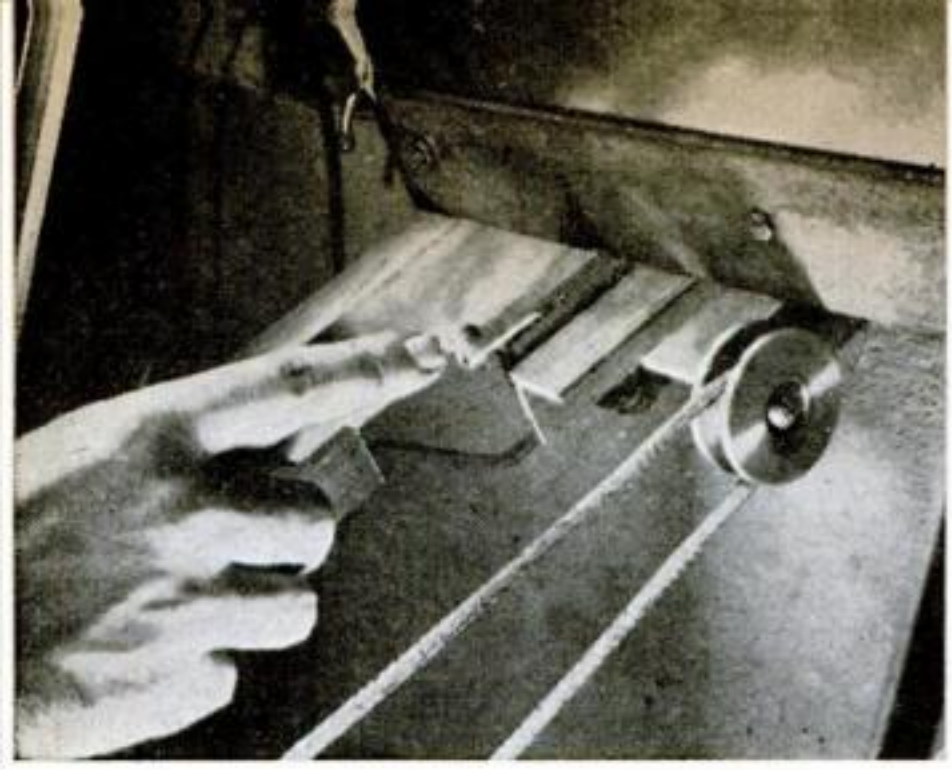


At the left is a close-up of one of the lenses in the Zeiss instrument that makes the "stars" for the Hayden shows. The stars are projections of tiny pinpoints of light formed by rays passing through copper pierced by holes. The stars have mathematically exact positions. Each lens covers 1/32 of the sky. The finger holds down the lens's "eyelid." The eyelid climbs up over the lens, as the lens moves downward to simulate the course of the stars. It prevents projection of the stars below the horizon of the earth.

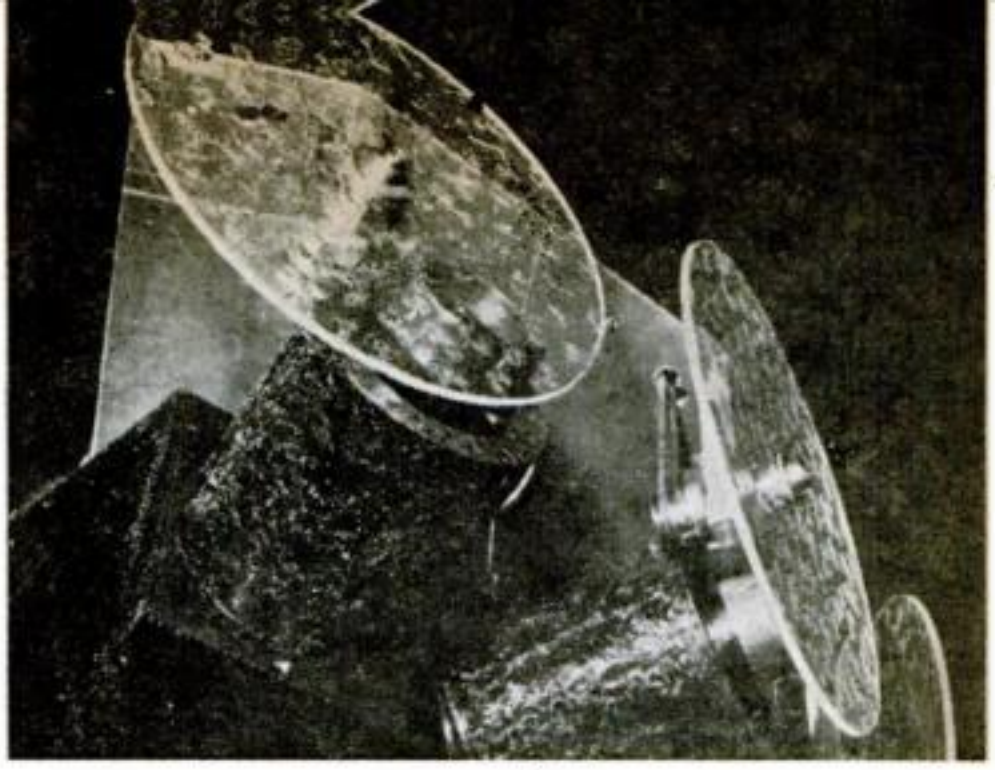


A section of one sphere of the Zeiss many-eyed projector is shown at the right. Looking from the top to the bottom of the picture, the reader can see that one lens is half covered by its eyelid, another is almost covered, while at the bottom the eye is completely shut. The tubes under each lens are weighted with mercury and their job is to act as levelers for the eyelids by keeping their edges at all times parallel to the horizon.

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When the image of the moon has expanded in the Planetarium sky just before "setting the world on fire" and has reached its maximum size, the arc-lamp housing hits the trigger pointed out above. This contact discharges an ordinary photographic flash bulb and extinguishes the arc lamp (whose function is explained in the caption at left). The flash and disappearance of the moon create the illusion that moon has blown up.



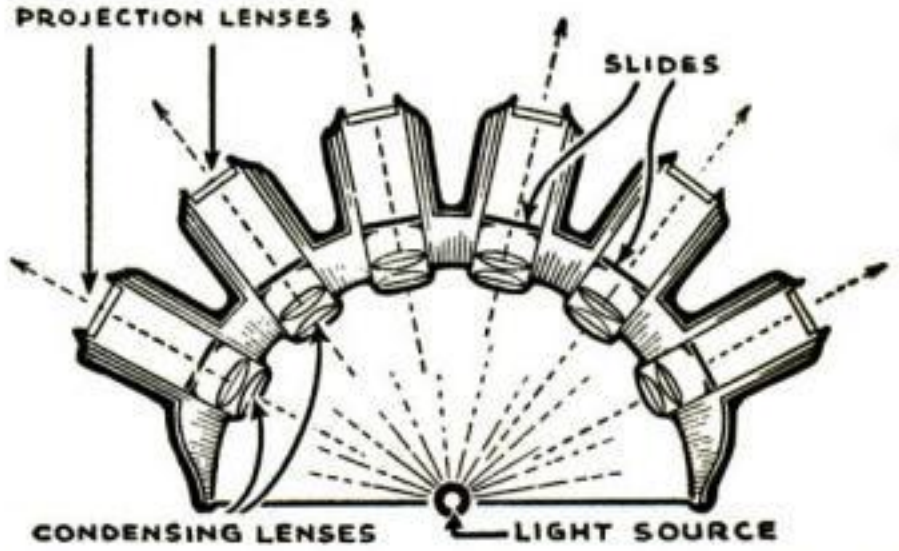
Above is a close-up of several Lucite disks blobbed with transparent cement. When rotated they give false flames a natural licking action. They are driven by belting of the type used in dentists' drills. Threaded through pulleys, the belting makes it possible to drive the six disks, in six different planes, with one motor. During the five acts at the Planetarium, Robert Coles, associate curator, explains the sky drama to the audience, using an arrow-projecting, six-volt flashlight to point out the stars, moon and the direction the action is taking.

are innocent victims of a celestial hit-and-run accident. The sun explodes as the result of a collision with a star from far out in space.

The fourth possible end of the world occurs when a mysterious wanderer from space, a comet with a flaming tail, appears on the celestial stage. It approaches the earth at bewildering speed. Closer and closer it comes until it strikes with a terrible impact. Where the earth was a fraction of a second before there is now only space. Though not probable, a collision between the earth and a comet is possible.

Astronomers know that some remote day the earth will pull the moon within the so-called "Roche's limit," a distance from the earth roughly twice the earth's diameter. What will happen then is shown in the awesome finale at the Planetarium.

Moving slowly at first, but gaining momentum as it approaches the New York skyline, a huge and terrifying moon soon fills half of the sky. There is a shattering crash as the moon explodes in the southeast horizon, breaking up into thousands of flaming meteors that bombard the mother planet. The skyline that rims the Planetarium becomes a circle of blazing buildings. As the flames die down, pieces of the shattered moon circle the earth similar to the moons of Saturn—a halo for a dead world!



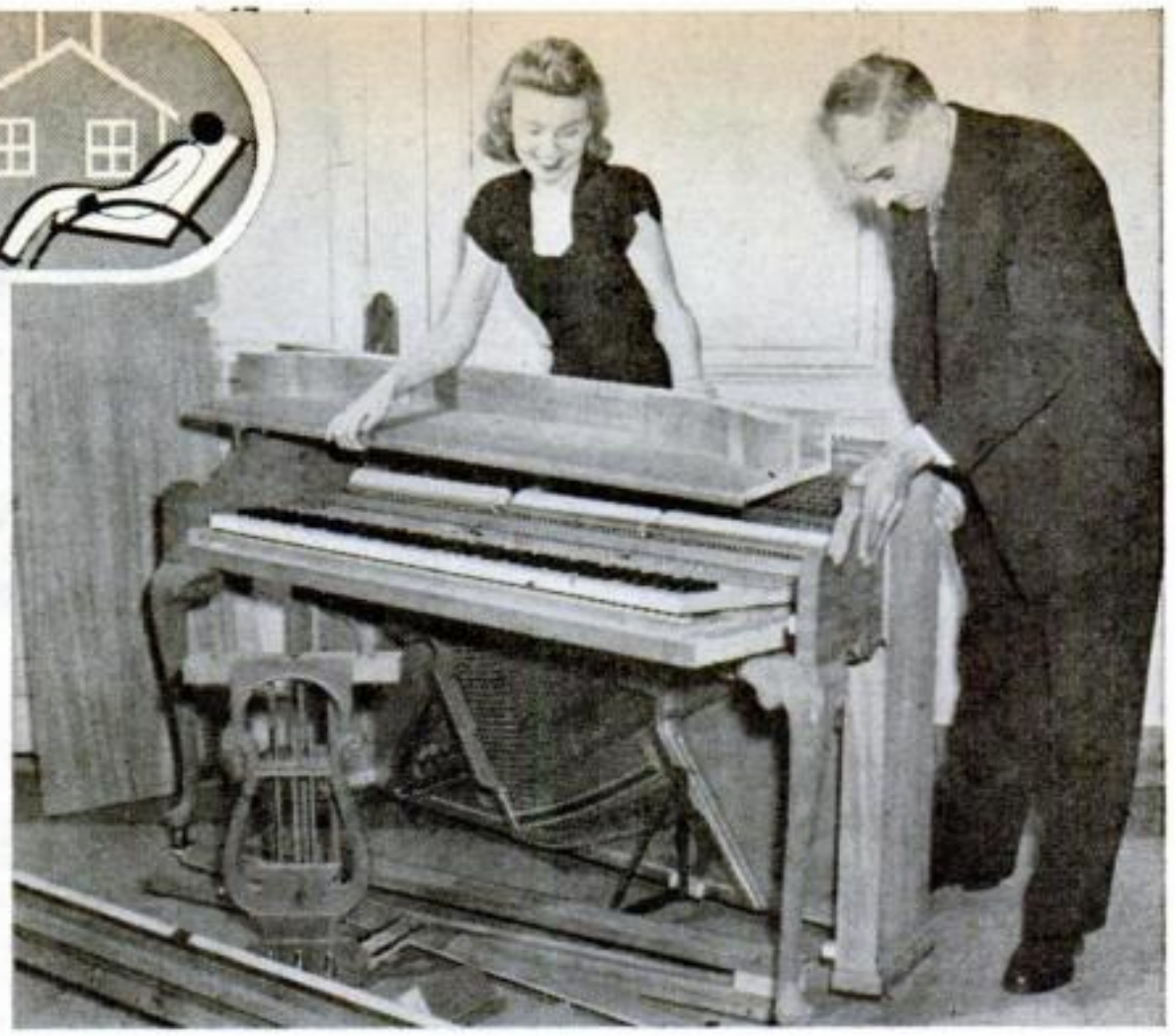
The diagram above shows how one light source is able to serve six projectors in the snow-covered and the burning-skyline effects.



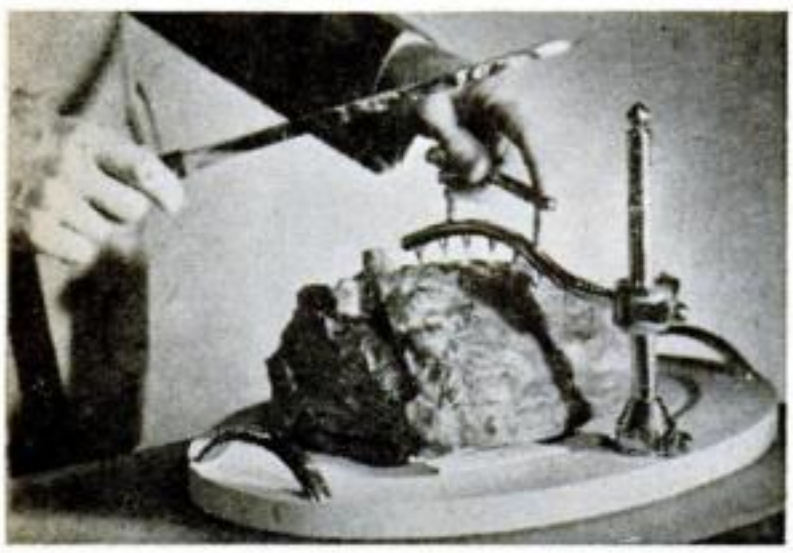
This is part of the show's skyline. It is cut out of the background and thus avoids the shadows that would be cast if the buildings were cut from some solid material and applied to the base.

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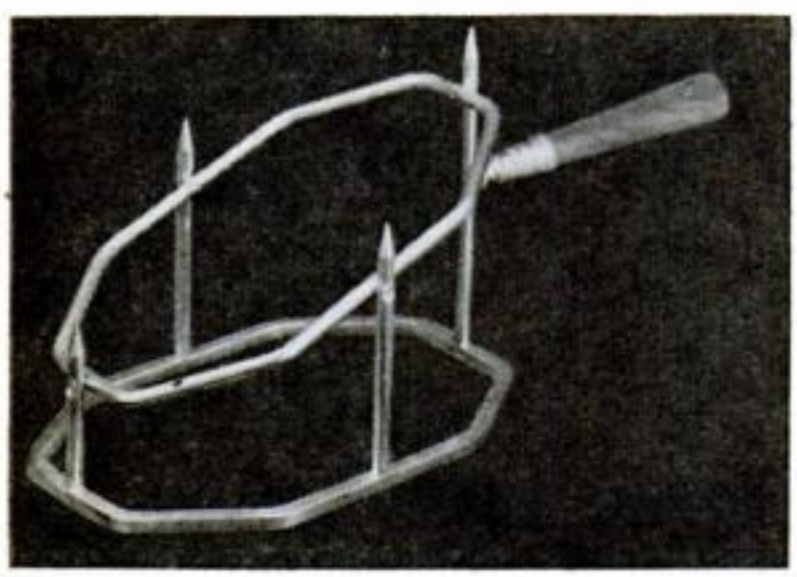
AIDS TO MODERN LIVING



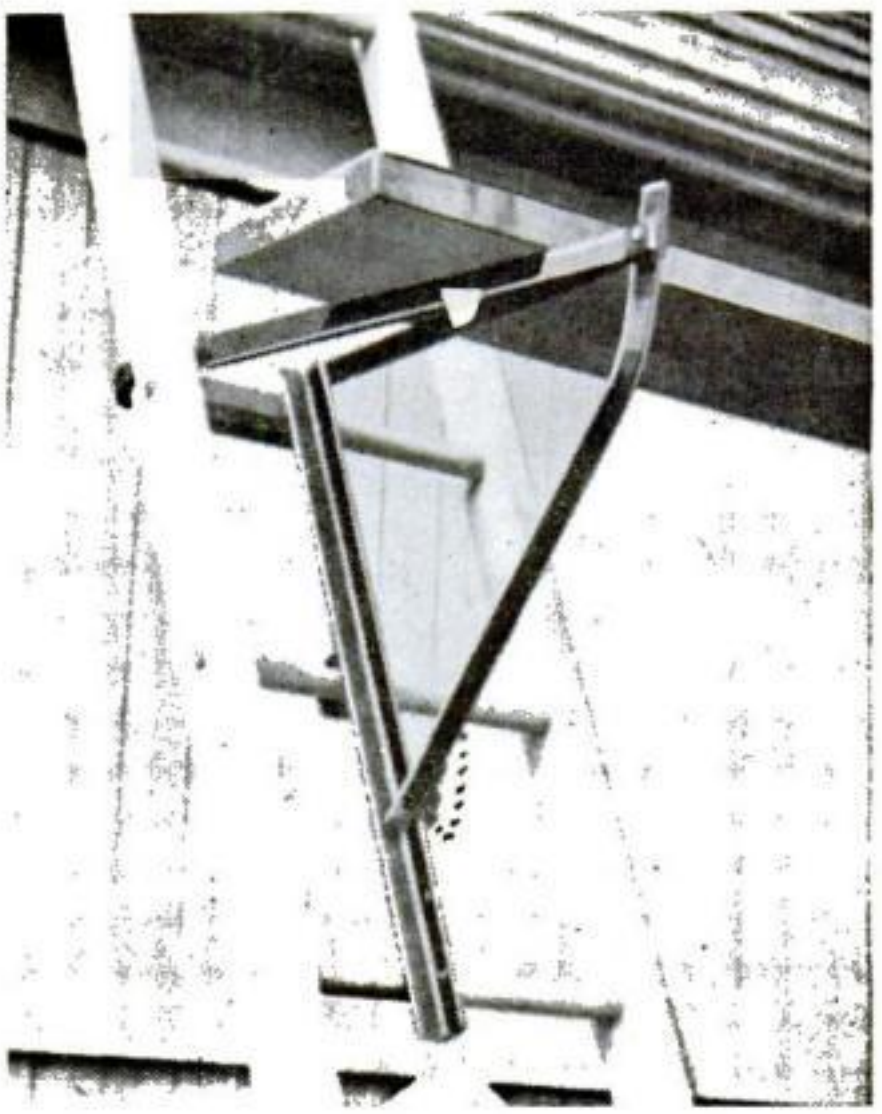
PULL-APART PIANOS manufactured by Pratt, Read & Co., Inc., of Ivoryton, Conn., are designed to make moving easier. Charles Frederick Stein, the inventor, shown at right, says one man can fit and secure the sections completely within a few minutes. Brass hinges with removable pins join the outer panels to the soundboard. Wood screws hold the other parts in place.



NEW CARVING AIDS for the Thanksgiving table include these. One, distributed by the Maxwell-Phillip Company, New York, has an adjustable arm to hold the meat or fowl in place. The one below, by Philip E. Ebb, New York, has spikes to grip the roast.



LADDER JACKS manufactured by Reimann and Georger, of Buffalo, N. Y., provide a sturdy scaffold at any desired height on two supporting ladders. The jack can be used over the ladder, as seen below, or under, adjustment being provided to make the scaffold horizontal regardless of the ladder angle. Once the adjustment is made, the triangle that is formed cannot collapse until the adjustment pin is deliberately removed.



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WATER FOR COOKING is right at the range in the kitchen below, saving the housewife many a step to the sink. There's a faucet on the end of a rubber tube which is pulled back into the wall by spring action after use. The scene appears in POPULAR SCIENCE on the Screen.





HOME HEAT requirements are automatically anticipated by a new thermostatic control that is actuated directly by outside temperatures. Designed to replace inside room thermostats and day-night switches, it produces heat at regular intervals, the heating periods automatically changing as the weather changes. All heating stops when outdoor temperatures rise above 65 deg. The control may be used with any type of heating system. Known as the "Weather Man," it is a product of Automatic Devices Company, of Chicago.

QUICK CLEANING is a feature of a new plumbing trap manufactured by the Bethlehem Industrial Corporation, of New York City. As illustrated in the photo at the right, the entire bottom of the trap screws off, allowing easy removal of sediment and any obstructing objects. The trap is made of brass castings, precision machined.



TWIN TUBS, one for washing and one for drying, are provided in the new washer produced by the Easy Washing Machine Corp., of Syracuse, N. Y. Both can be used at the same time. Making a wringer unnecessary, one tub dries the clothing by centrifugal force. The washing cycle is controlled by setting a switch for the kind of fabric.





MEN'S HATS made of plastic fibers combined with wool in a special weave are now on the market. American Viscose Corporation, of New York, produces the material, which is water-repellent, nonshrinking, nonstretching, and extremely lightweight.

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Gus Starts a Stop-and-Go Customer



JOE CLARK had gone to the bank, and Stan Hicks was left in the Model Garage office-showroom to take a turn at answering the telephone.

"Yeah, all right," he shouted into the transmitter. "What's the name again?"

"Spinker!" snapped the voice.

"Shrinker," Stan repeated confidently. "What didja say the address—"

The line sizzled. "Not Shrinker, you dope! Spinker! *S-p-i-n-k-e-r!*"

"Oh, *now* I get you, Mr. Stinker," Stan said in a pleased voice. "Whatja say the address was?"

Expletives answered him. "I've told you three times where I live!" barked the irate Mr. Spinker. "*One-seven-two* Orchard Street. Now get moving, will you?"

"Yeah—you bet," Stan said soothingly and hung up. The sports page he had been reading when the telephone interrupted caught his eye. He picked up the paper, elevated his feet on Joe's spotless desk, and took up where he had left off. Then he went on to the comic strips, and he was deep in them when Joe came back.

"Nothing important," the grease monkey reported, and he strolled into the shop.

Gus Wilson looked up from the job on which he was busy. "Check the tube in the left-rear tire of that coupe," he directed. "Tom Barnsley says it acts as if it had a high-pressure leak."

"There's a rush job," Stan told him importantly. "Fellow named Stinker, 72 Orchard Street, just called up. Says he can't get his car started. Want me to go?"

"I'll go," Gus decided. "You find out what's the matter with Tom's tube. Stinker! That's a funny name. Sure you got it right?"

Stan reassured him, and Gus got the wrecker out and drove it the 10 blocks to Orchard Street. Where No. 72 should have been, there was a vacant lot. The precise lady at 88 said that she had never heard of anyone by the name of Stinker and intimated she thought it indelicate of Gus to have mentioned it. A red-faced woman at 66 remarked caustically that none of her neighbors was named Stinker although some should be.



"Shut up, jerk, or I'll crown you," she said, grasping the broom menacingly.

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It took Gus 15 minutes to find out that the name was Spinker and the number 172, and he wasn't at all happy about it when he drove the wrecker up the driveway at that address. The doors of the garage were closed, so he rang at the front door. A harried-looking young woman answered.

"It was *hours* ago that Mr. Spinker phoned," she told him bitterly. "My husband is a busy man, and he couldn't wait."

"Oh, I see," Gus said, feeling foolish. "So he got his car started?"

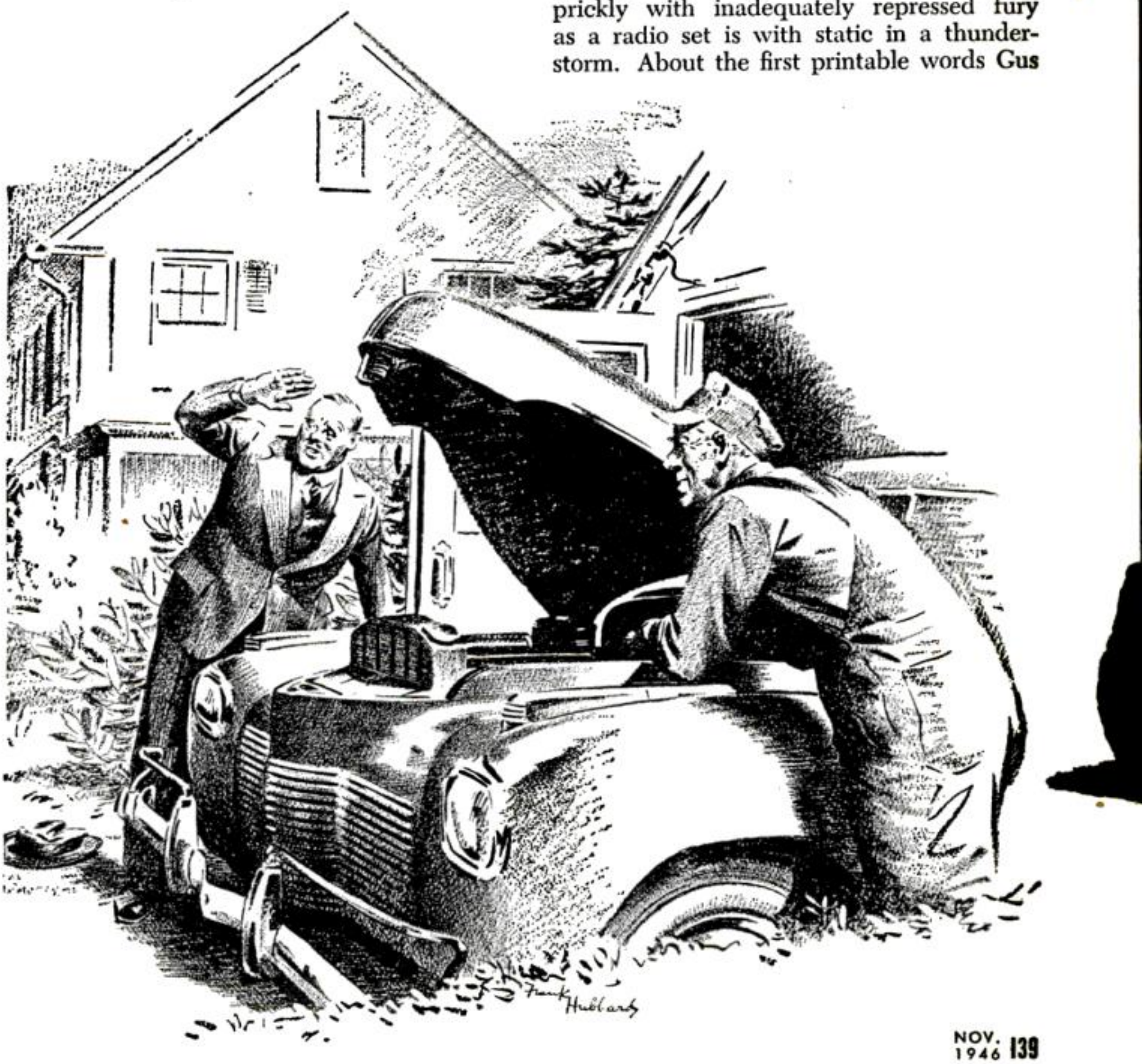
"Mr. Spinker has a terrible temper," she said with more than a touch of pride. "When you didn't come promptly, as you'd promised, he lost it and slammed the car door good and hard. Then, when you still didn't come, he tried the starter again, and it worked. So now we don't need you!" Then she slammed the house door.

He drove back to the Model Garage and took the matter up with Stan—with the result that the grease monkey, who had put a new tube in Tom Barnsley's tire, was as deflated as the one he'd taken out.

But Gus isn't one to nurse a grudge, and within a week the Spinker incident had ceased to be a subject for reproach even if the embarrassment hadn't been forgotten. Nevertheless, Stan looked sheepish when he came into the shop just after opening one morning and said: "You're wanted on the phone, boss. It's—it's that fellow over on Orchard Street who couldn't get his bus started. He won't talk to anybody but you."

Gus grunted, went into the office, and picked up the telephone. The voice that sprang at him out of the receiver was as prickly with inadequately repressed fury as a radio set is with static in a thunderstorm. About the first printable words Gus

By MARTIN BUNN



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heard were: "My car won't start, and I've got to get to the office. Come over here and see what's wrong with it!"

"Look here," Gus told him crisply, "I haven't time to go driving around town on fool's errands. If you want me to check your car, stay right where you are until I get there. Understand that?"

Over the wire came a new volume of expletives, and then the voice said: "All right—I'll wait! Make it fast!"

AS HE drove the wrecker across town, Gus indulged in mentally portraying the terrible-tempered Spinker. He pictured him as a big man with a red face and red hair—and he was right, for that was just the sort of man who was waiting for him.

When Gus drove up, the man stuck out his wrist watch. "Look," he roared. "A quarter to, and I've got an important engagement at my office at nine. About time you got here! And don't call me Stinker!"

"O.K.," Gus agreed, grinning. "Let's have a look at this on-again-off-again jalopy."

"Jalopy!" howled Spinker. "It's a '41 model. Don't look at it. Start it!"

He led the way to the garage. "Been kicking the starter for half an hour," he growled, "without getting a turn."

"Why didn't you slam the door? That worked before," Gus said with a grin.

"I did, and—" Spinker's red face got still redder. "How did you know that?"

"You look the type," Gus said dryly, and got into the driver's seat. The ignition was on. He pressed the starter pedal, and the engine took off with a purposeful roar and ran without a miss or sputter.

Spinker was wearing a derby. He snatched it off with both hands, hurled it to the ground, leaped high into the air, and came down on it with both feet. His jaw worked soundlessly for some seconds, and then two bitter words emerged from under his red mustache: "Confounded trickery!"

"Take it easy, or you'll bust something besides your hat," Gus advised. "You aren't the first man who's been made a sucker by an automobile electric system."

But Spinker wasn't to be consoled, and his shouting and expletives finally brought his wife from her sweeping, broom still in hand. She gave Gus a nasty look, and then addressed her husband in dulcet tones.

"Hush, Horace dear. Control yourself. Think of the children," she told him.

He went on yelling. Mrs. Spinker's thin-lipped mouth tightened. "Shut up, jerk, or I'll crown you," she said, grasping the broom menacingly.

Spinker's yelling stopped as abruptly as if he'd been gagged. His mouth opened and closed soundlessly half a dozen times.

"Why does the car start sometimes and not start other times?" he asked huskily. "Why did it start every morning for a week when I slammed the door, and why didn't it start this morning when I nearly slammed the hinges off? Why did it start for you and not for me? Why? That's what I want to know."

Mrs. Spinker turned her gaze from her husband to Gus, and in her green eyes there was the look of a watchful bobcat. "Tell him why," she said briefly.

Gus grinned. "I'll have to find out myself," he told her.

He poked under the hood at various wiring connections with an exploratory forefinger. After he had got to the starter motor and poked the lug on the starter switch, he straightened up.

"There it is," he said. "That lug is so loose it forms a high-resistance connection—passes enough current to operate the lights and horn, but usually it can't pass the several hundred amperes necessary to turn over a cold engine."

He raised a warning hand as Spinker showed signs of sounding off again.

"In this particular case," he explained, "the lug is so loose it can't pass enough current to operate the starting motor. Slamming the door sometimes jars it together so starting is possible. Lots of times the same thing is caused by loose battery terminals."

Gus removed the loose lug, cleaned it with waste from his coverall pocket, and replaced it. He tightened it until it was snug.

"That will get you to your office," he said, "but you'd better bring your car over to my shop for a check on all the wiring."

Spinker looked at his watch. "Suffering cats!" he yelled. "I've got to get going!" He jumped into the car and started off, yelling to his wife: "Pay this fellow!"

Gus climbed into his wrecker. "I'll send the bill," he told Mrs. Spinker.

She nodded. There was a far-away look in her eyes. "I hate to see Horace go in the morning," she said. "It's so—so sort of lonesome when he isn't around."

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AUTO HINTS

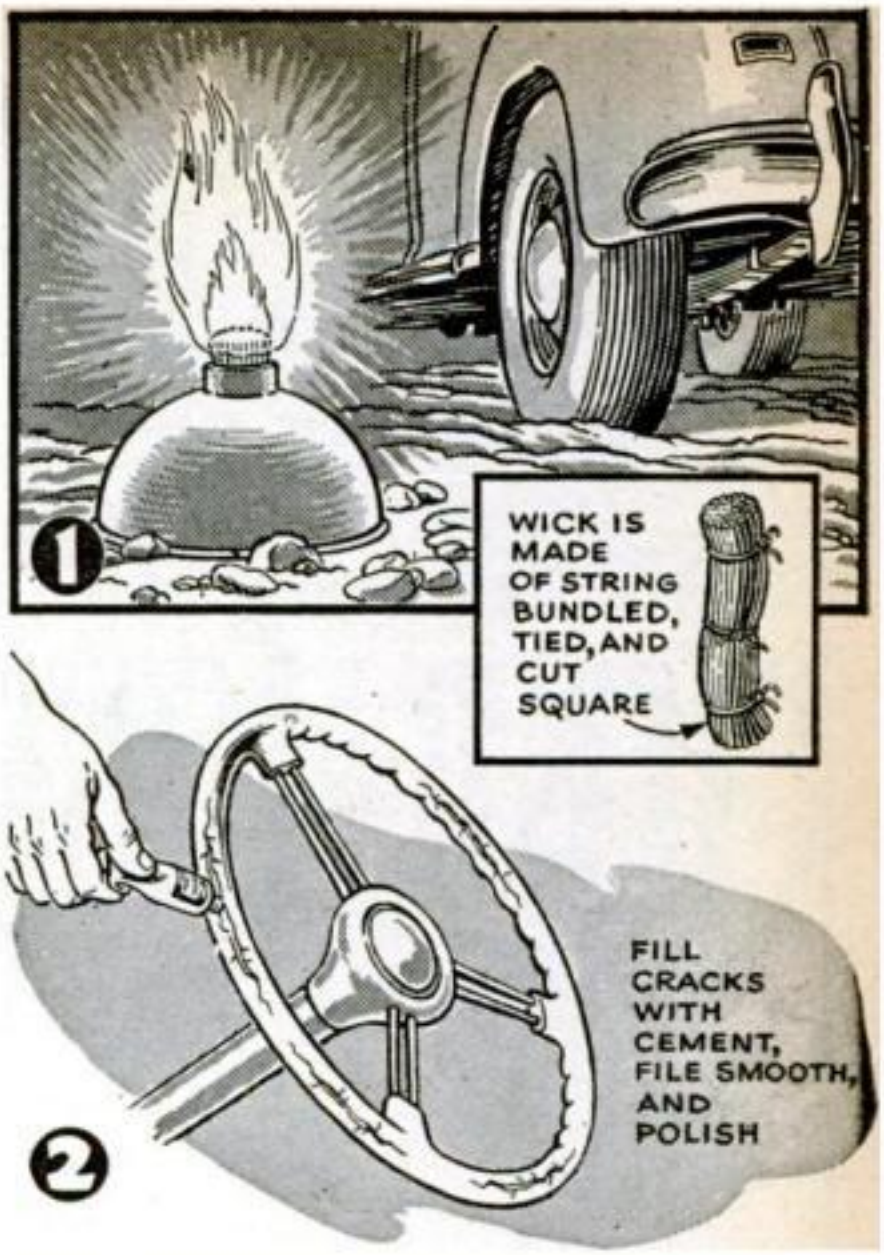
1. THIS ROADSIDE FLARE, a good warning light for nighttime highway stops, is made from the bottom of an old oilcan. The wick is cotton wrapping cord tied into a bundle of the diameter of the hole and cut square at both ends. Kerosene is good fuel. A bottle cap covers the wick when the flare is not in use.—H. K.

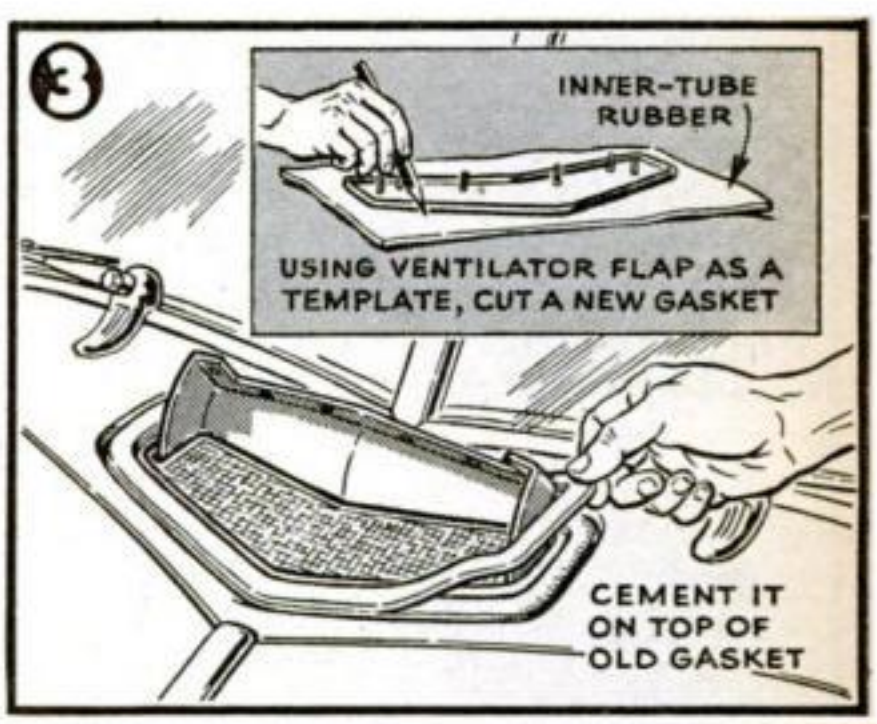
2. STEERING-WHEEL CRACKS can be filled with clear cellulose cement so they won't be noticed. Scrape out and clean the cracks in the plastic and force in the cement in one or more applications. File and polish when dry.—W. A. W.

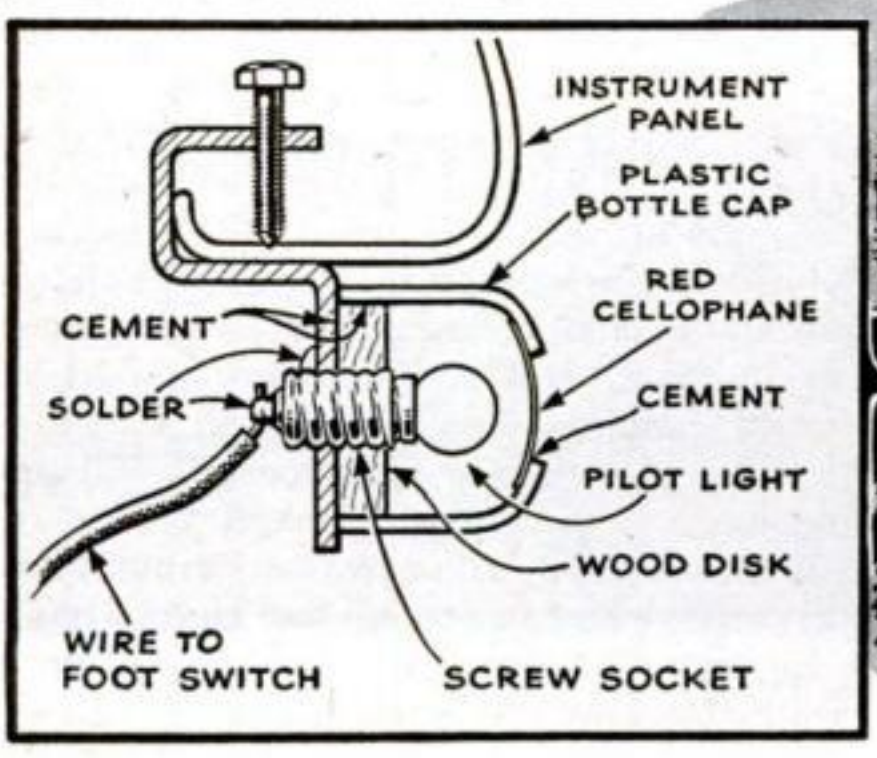
3. LEAKS IN A VENTILATOR are best repaired with a new gasket, which can be cut from an old inner tube. Remove the ventilator flap, trace and cut a ½" gasket, and cement it to the old rubber. Replace the flap, put some wax on the new gasket, and close the flap to provide pressure.—D. Z.

4. WIRING A HEADLIGHT INDICATOR on the dashboard is simply a matter of carrying a wire from it to the high-beam terminal on the foot switch. A pilot-light fixture may be purchased or made up from a steel clamp, machine screw, wood disk, socket, and a plastic bottle cap.—A. W. C.

Drawings by STEWART ROUSE









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Standing sentry over your engine are heat-sensitive little gadgets that make the difference between carefree motoring and engine troubles.

THERMOSTATS on Guard

By WILLIAM H. CROUSE

IF YOUR engine has a tendency either to overheat or to warm up sluggishly, better take a look at the thermostat or thermostats between the radiator and engine. Either difficulty is a pretty good sign that this vital automatic control is failing to do its job. Taking the tip may save you a big repair bill later.

Two types of thermostats are used in the cooling system of modern cars. The bellows type is the more common. It consists of an airtight, flexible bellows of copper or bronze containing a few drops of a volatile liquid. As the water heats, this liquid boils, the pressure expands the bellows, and the bellows opens a valve in the water line to the radiator. The other is the coil-spring, bimetal type, its action depending on two metal strips that expand at different rates.

Ideally, automotive engineers would like to have an engine operate at a temperature just short of boiling away the cooling water. An overcooled engine wastes fuel, develops crankcase sludge, and performs inefficiently; an overheated engine is not only inefficient but also liable to serious lubrication troubles.

In addition to keeping a nice balance between heat removal and maximum heat needs, the thermostat also must hurry the engine through the warm-up period. You would notice failure in the latter respect particularly on a cold morning, for the engine might continue to splutter and cough for miles before settling down, if at all.

When an engine is cold, the thermostat shuts off water flow through the radiator, permitting it to circulate only in the upper and lower engine jackets. On many engines the pressure of the water pump opens a spring-loaded valve in the bypass between the upper and lower jackets when the radiator line is closed. With water circulating only within the jackets, the engine quickly warms up. Then the thermostat opens and allows water to pass through the radiator.

In some cars, other thermostats help along the warming process. One closes the radiator shutter, preventing air from passing through the radiator until the engine is warm. Another operates the automatic choke, closing the valve to enrich the fuel-air mixture when the engine is cold and opening it to give a lean mixture for normal conditions. A third controls a valve that diverts hot exhaust gases into the heat-riser oven that surrounds part of the intake manifold. This preheats the fuel-air mixture.

Not only does a short warm-up period save gasoline and reduce wear on moving engine parts, but it helps prevent formation of sludge in the crankcase. Sludge is a black, mayonnaise-like substance formed when oil and water mix, the water condensing from air passing through the crankcase. Normally, this water evaporates and is driven out, but on short trips, or if the engine heats up slowly, the water accumulates and sludge forms, impairing lubrication.

When the thermostat allows the engine temperature to rise too high, the antifreeze and cooling water boil away and high-temperature sludge may form in the oil. High-temperature sludge, entirely different from ordinary crankcase sludge, results from a

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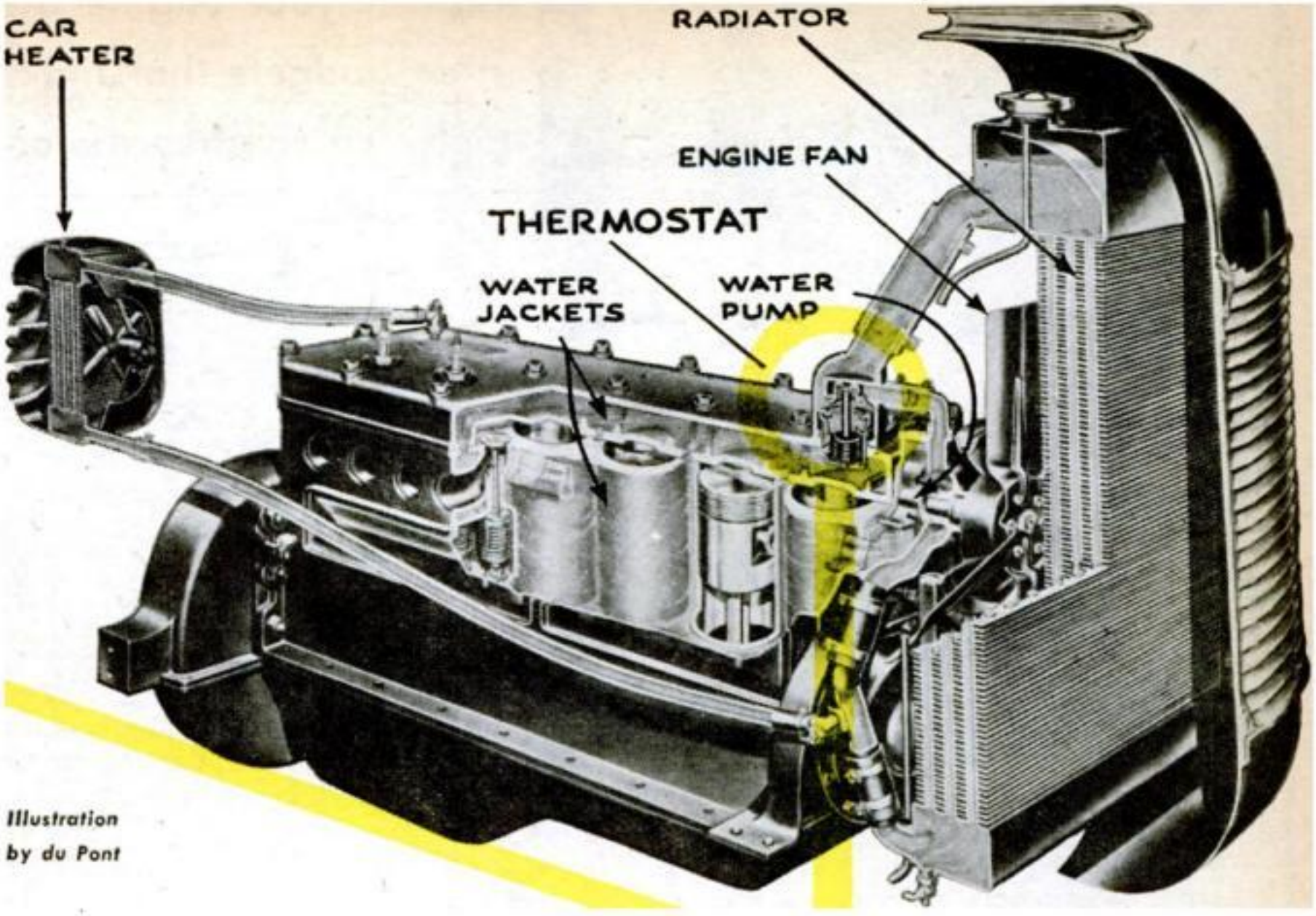


Illustration by du Pont

Kingpin of the cooling system is the thermostat. It prevents overheating and speeds engine warm-up.

chemical change that produces small hard particles in the oil. These block passages in the lubricating system.

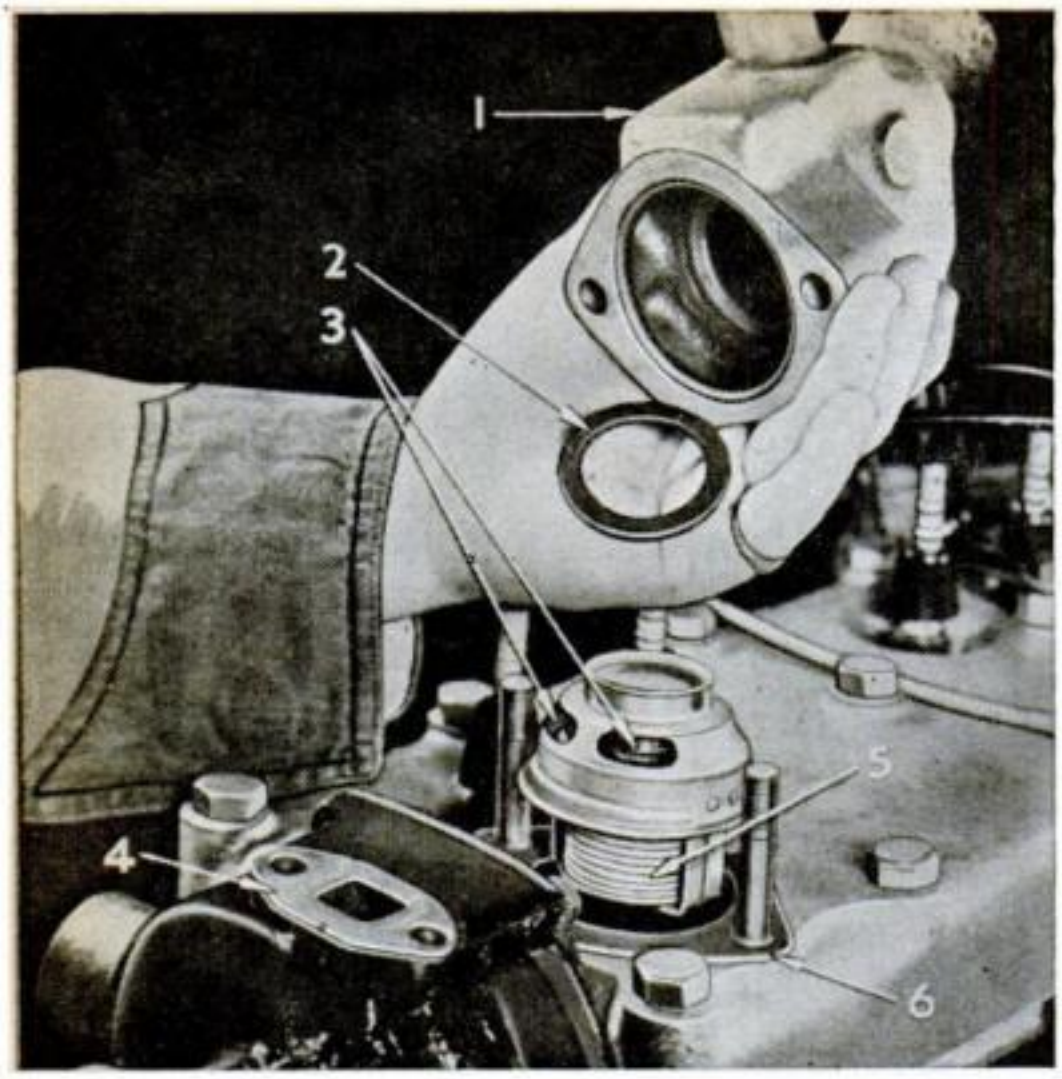
In seeking to keep engine temperature within definite limits, automotive engineers must consider the great variety of driving conditions that engines encounter. Some engines are routinely operated at high speeds or under a heavy load while others are largely driven under opposite conditions. Climate, atmospheric temperatures, and altitude also are factors. Fortunately, the thermostat can balance all of these. For example, the thermostat may open only slightly, or possibly not at all, in extremely cold weather if the car heater is removing enough heat from the system.

As you might expect, the most efficient temperature ranges vary with different engines. One car uses a thermostat which starts to open at 151 deg. and reaches wide-open position at 173 deg. In another, the thermostat begins to open at around 160 deg. and is open at 183 deg. In general, where a temporary or alcohol-base antifreeze is used, a thermostat that operates at somewhat lower temperatures is desirable since such antifreeze compounds boil at lower temperatures than water. With the exception of a few types, thermostats are not adjustable, and a different thermostat must be installed to change the operating temperature. However, engineers have another trick up their sleeves to increase engine temperature without danger of boiling.

This is the sealed cooling system with a radiator or expansion-tank pressure cap. The cap contains a spring-loaded blowoff valve that remains closed until as much as 12 lb. above atmospheric pressure builds up in the cooling system. This increased pressure raises the boiling point of water from 212 deg. (at sea level) to about 250 deg., with a comparable increase in the boiling point of an alcohol-water coolant. The cap also contains a vacuum valve that opens when the engine cools, allowing air to enter and prevent a vacuum that might collapse the hose or radiator.

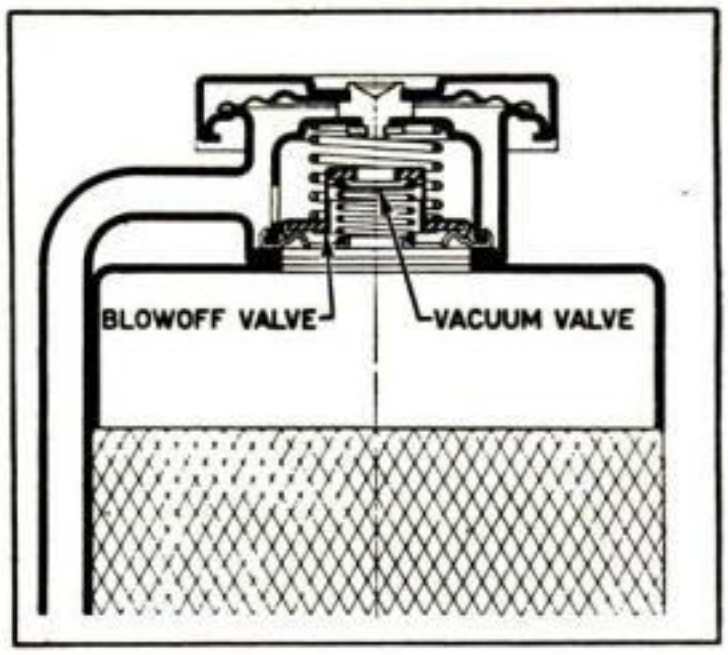
If you have paid attention to the action of your heat indicator, you know about how far you must drive before the pointer begins to show that the engine is warming up. In cold weather you naturally must drive somewhat farther before this occurs. But if you drive a long distance and the gauge

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Numerals on this photo indicate the parts of a thermostat. 1, housing; 2, gaskets; 3 and 4, openings for bypassing water if the valve is closed; 5, the thermostatic bellows; 6, housing gasket.

Photo by Chrysler



In sealed cooling systems, a pressure cap like this on the radiator or expansion tank raises the boiling point of the coolant.

shows no change, you can suspect that the thermostat is stuck in the open position. (Sometimes the temperature gauge is stuck or defective.) Failure of the heater to give out enough heat is an even more noticeable indication that the thermostat is stuck.

You can quickly check thermostatic action. When the engine is thoroughly cool, start it, and, after a few seconds, feel the top water tank of the radiator or take the radiator cap off and test the water with a finger. If there is any warmth, the thermostat is open and allowing water to flow to the radiator before the engine has reached operating temperature. With a cold engine, hot water should not be delivered to the radiator for several minutes at least.

This is not a foolproof check, but it will give you a good idea of what the thermostat is doing. A positive check requires removal of the thermostat. First drain the cooling system until the water level is below the thermostat housing. Then remove the upper water hose and thermostat housing, and the thermostat can be taken out.

Suspend the thermostat and a thermometer in a pan of water so that neither touches the bottom. Now heat the water and observe the temperature at which the thermostat begins to open and the point at which it is fully open.

Although a thermostat stuck in the closed position may cause an engine to overheat, there also are other possibilities. Extremely high temperatures (for example, those found on a desert) may prevent the cooling system from functioning satisfactorily. A sticking manifold valve may not close off the heat-riser oven. Lack of oil and overloading also bring about overheating.

Most often, however, we think of the cooling system first when an engine overheats. This can be quickly checked. Make sure first of all that there is water in the radiator. Then turn off the engine and look at the fan belt. A loose belt may slip and not turn the fan sufficiently fast to draw the neces-

When cold, the thermostat bars circulation in the radiator, left. After the engine is hot, the water goes into the entire cooling system, right.

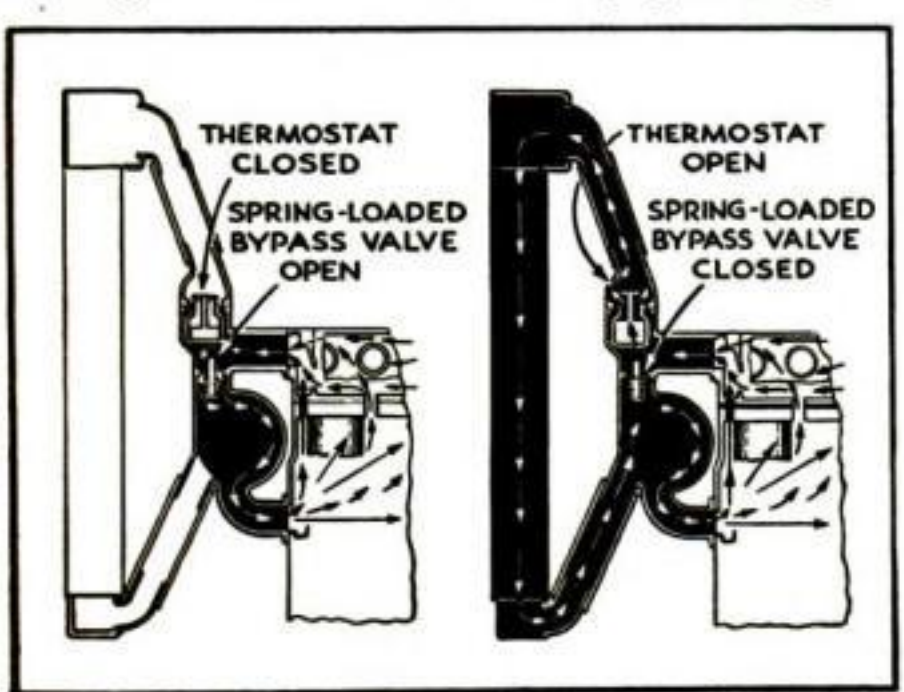


Diagram by Buick

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sary amount of cooling air through the radiator. The belt can be tightened on most cars by loosening the generator mounting and shifting it slightly. But avoid excessive tightening of the belt, for this is hard on both belt and bearings.

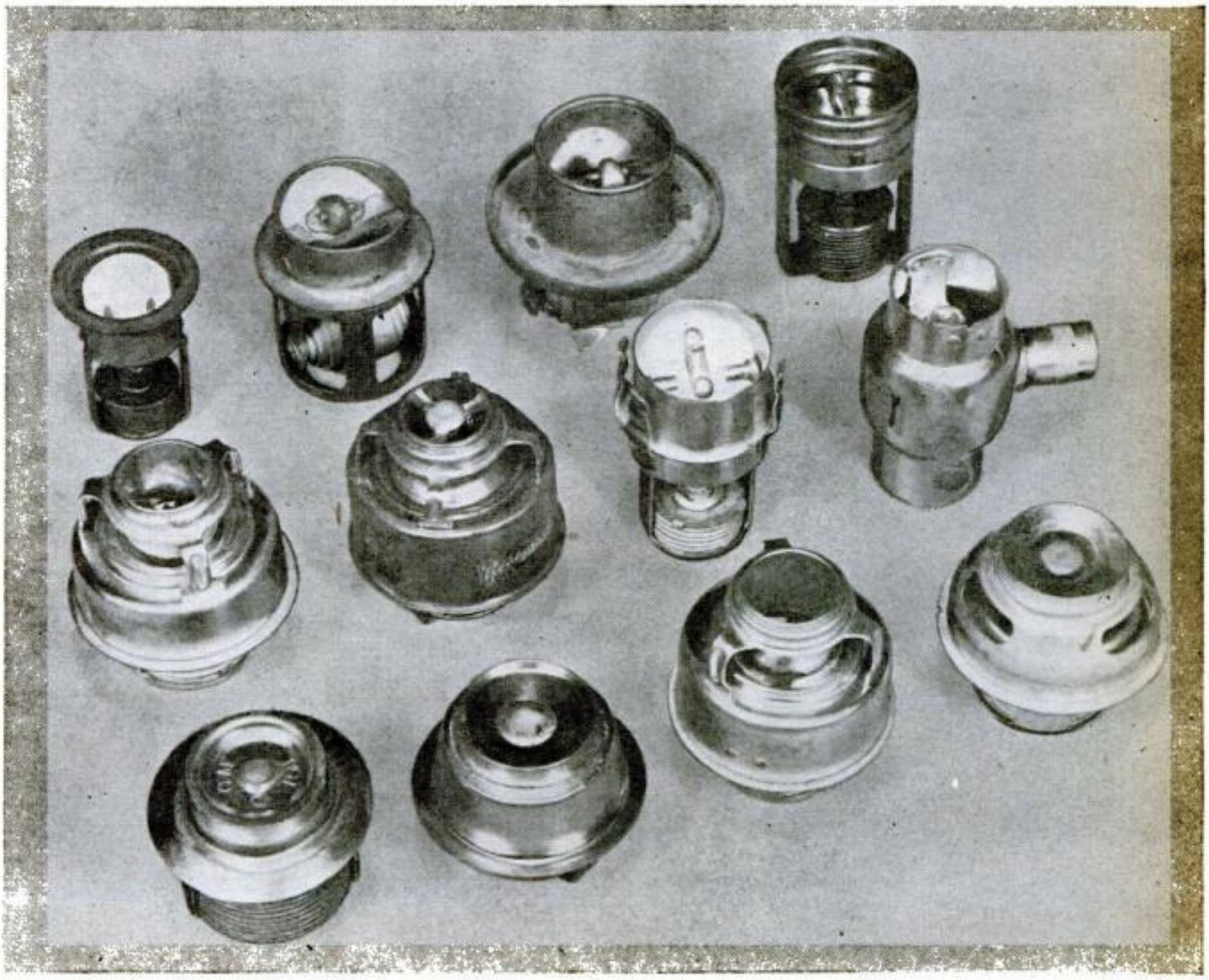
Particularly on cars with sealed cooling systems, be careful in removing the cap to look at the water—or you may be burned by steam. In the sealed system, the sudden reduction of pressure may permit a powerful boiling action. Pressure can be reduced slowly by turning the cap slightly and waiting a moment before removing it.

If you suspect that the overheating results from a thermostat stuck in the closed position, a check can be made by operating the engine for a few minutes until it is hot, and then feeling the radiator. If the radiator is cold, you may feel reasonably sure that you have located the trouble. If the radiator does warm up a little, you then have four possible trouble causes—the thermostat, the water pump, the hose, or accumulations of rust and scale.

When water in the cooling system is rust-colored or dirty, it seems likely that rust and scale may have impeded circulation. For a modest charge, garages will add cleaning compounds and flush out the cooling system, or you can do it yourself with a garden hose. The thermostat should be removed and the radiator and engine jackets flushed.

Some idea of water-pump action can be gained by pinching the upper hose to the radiator closed while the engine is running. (Keep your hands clear of the fan!) If the water pressure in the hose is felt to increase materially as the engine is speeded up, the pump probably is operating satisfactorily. Next, release the upper hose and watch the lower hose as the engine is speeded up. Rotted or worn-out hose often collapses as pump suction goes up with increased engine speed. This chokes off the flow of water. Such hose should be replaced.

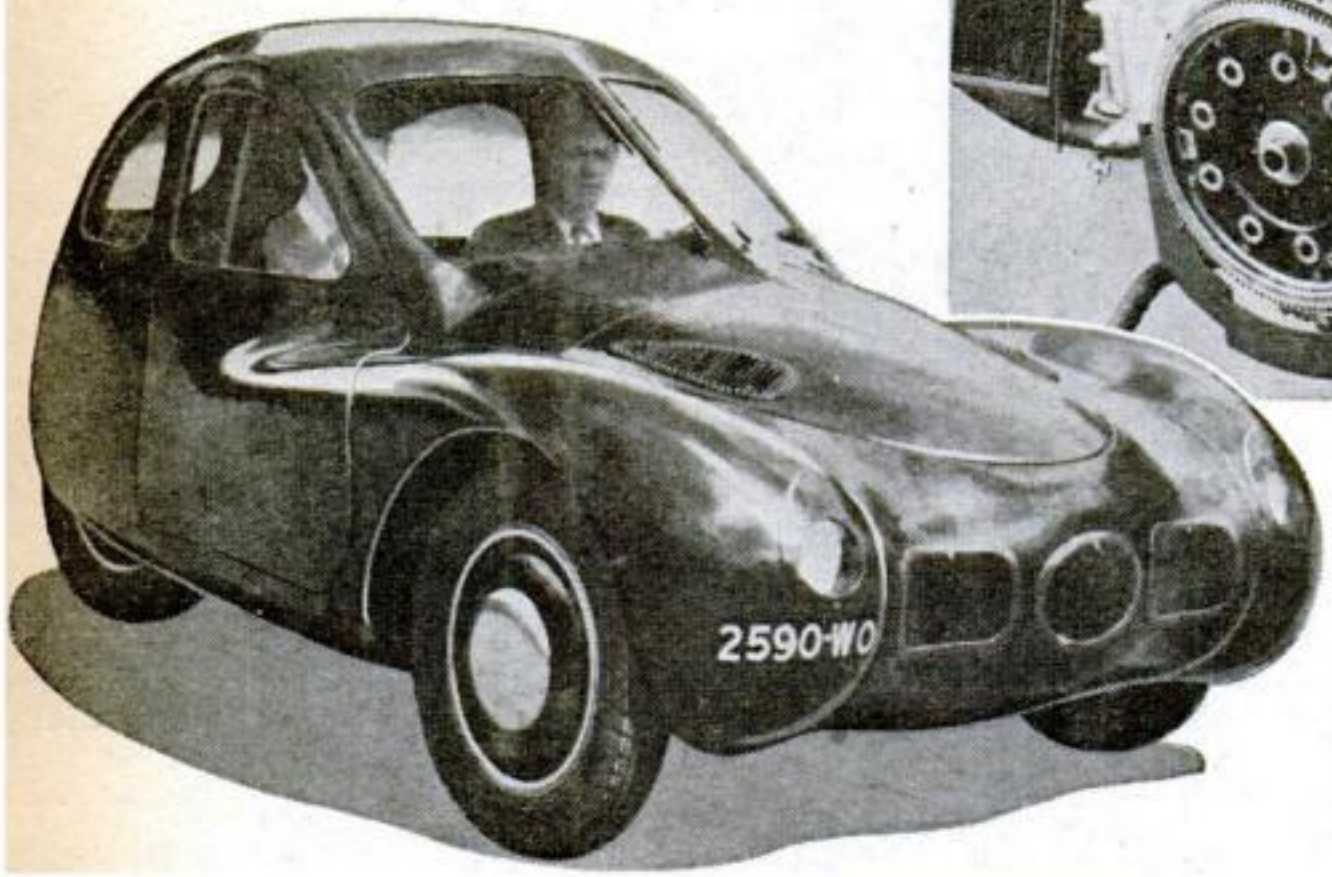
Thermostats used in the cooling systems of automobiles present a varied appearance, but there are only two general kinds. One is the familiar bimetal type, the other a bellows containing a volatile fluid.

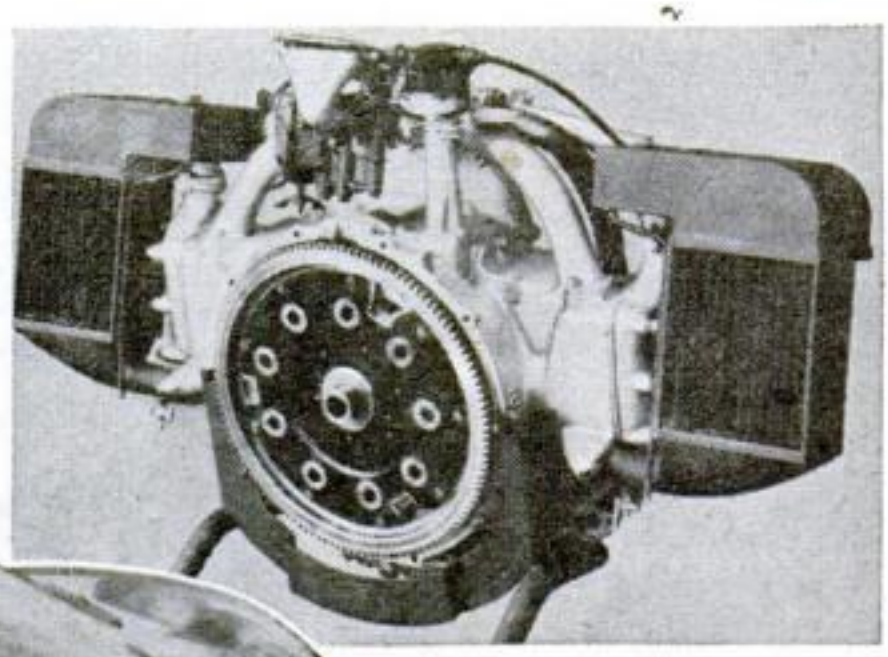


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AUTO IDEAS

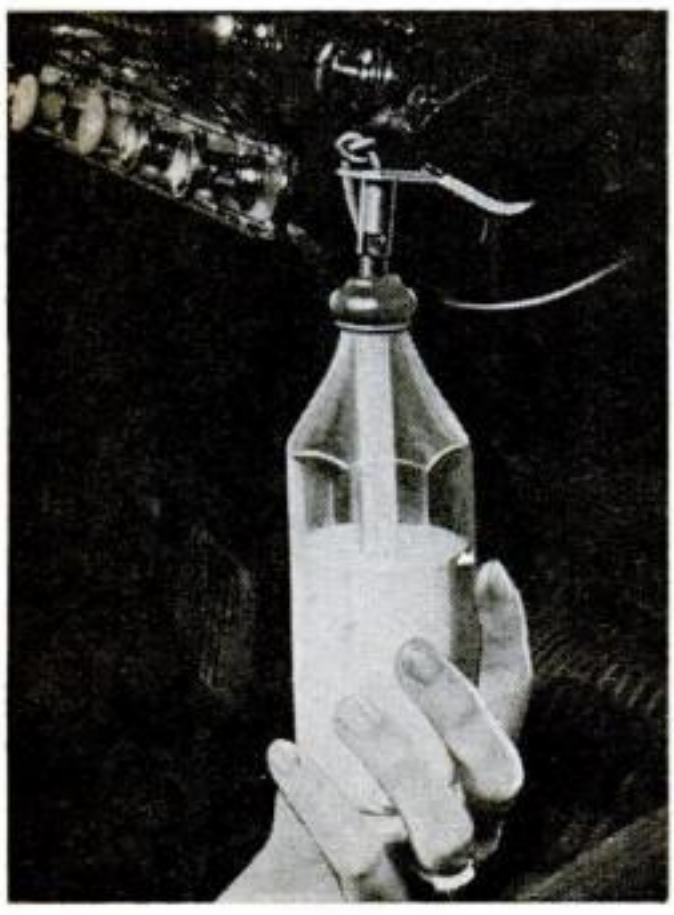
ONLY THREE WHEELS support the newest car to appear among the current French crop of small, light automobiles. The "Mathis" has a front-wheel drive and seats four—three in front and one crosswise in the rear. A water-cooled, twin-cylinder opposed engine with dual radiators powers the car to a top speed of 70 m.p.h. More than 100 miles per gal. at 45 m.p.h. is the mileage claimed by the designer.

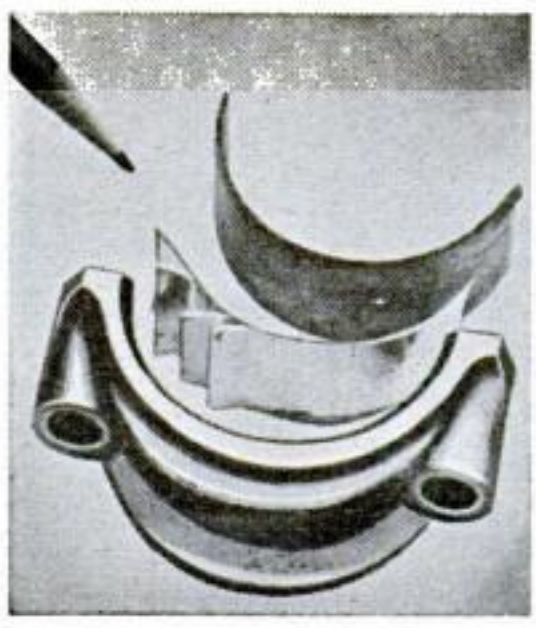




The small, flat twin engine shown above gives top speed of 70 m.p.h. At left, tricycle construction can be seen. Note the narrow rear end, which has room for one person sitting crosswise.

BABY'S MEALS can be served en route with a new accessory. An ice-cube cooled container stores a bottle until feeding time, when it is warmed by an electric heater that plugs into the dashboard. The "Papoose" is made by C. & C. Mfg. Co., Chicago, Ill.





A TAPERED SHIM that will compensate for irregular wear on motor bearings is reported to be extending the useful life of old cars. Tapered in thickness from .004" to .0005", the feather shim restores full rolling surface to used bearings, reports the inventor and manufacturer, A. H. Blaisdell of Long Beach.

RECESSED so that it won't catch on clothing or bang careless wrists, a new type of steering-wheel spinner is mounted within the rim. Because it lies on a shorter radius, it provides even faster turning than a rim-mounted one. Northwest Tractor & Equipment Co., Minneapolis, Minn., makes it.



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MECHANICS AND HANDICRAFT

- Carbon-Arc Brazing Torch
- Portable Radio-Phonograph
- Repairs with Iron Cements
- HO-Gauge Streamliner
- Table-Top Color Pictures

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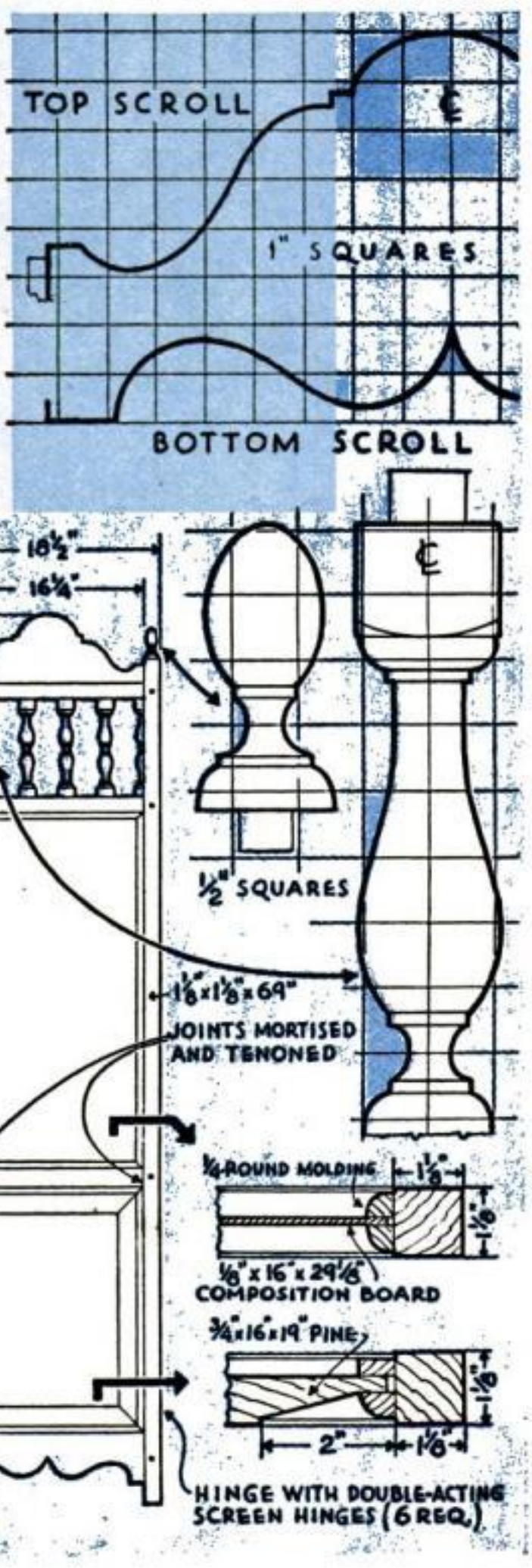


Colonial

PINE SCREEN

Frames Old Maps

CRAFTWORK for CHRISTMAS

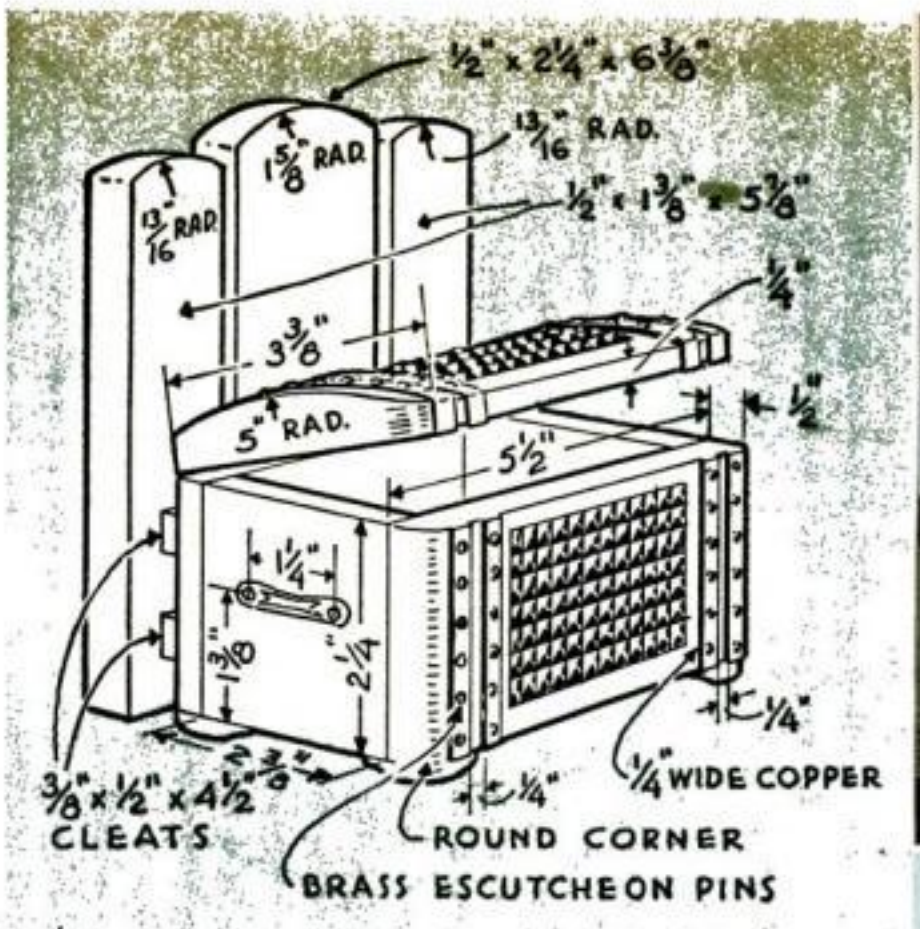


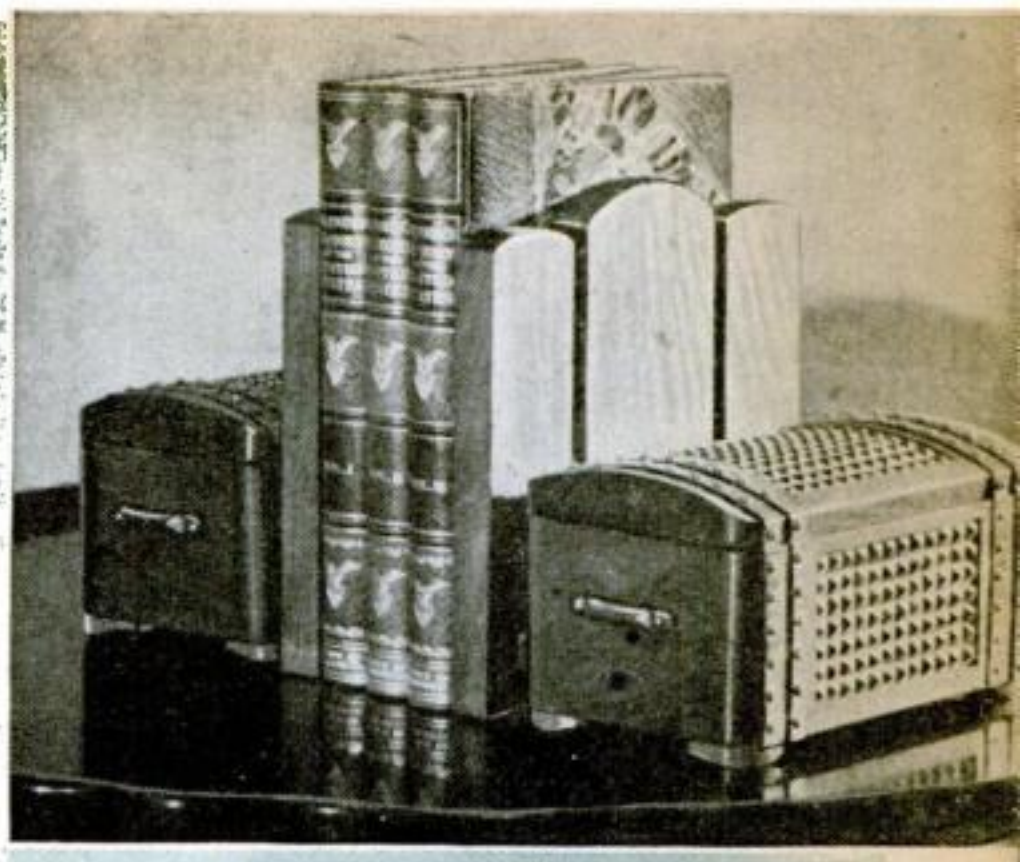
SHORT wood turnings, some simple jigsaw work, and sets of beveled and decorated panels combine to make a period screen appropriate for an Early American room. Either clear or knotty pine is suitable, but knots must be firm, and they should be kept away from joints and shellacked before finishing.

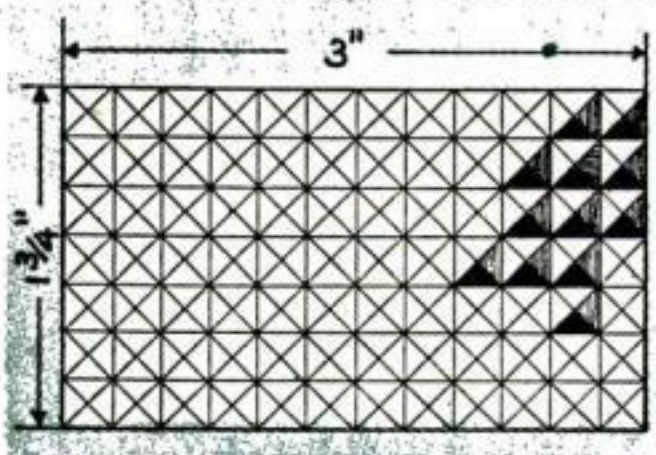
All three screen sections are exactly alike, except for the upper-panel decorations where variety is desirable, and are joined with double-acting screen hinges. Mortise the turnings into the top rails and glue the rail tenons into the stiles. Drill and peg the mortise-and-tenon joints or put in countersunk screws puttied to appear as pegs.

Dimensions for the panels are ¼" less than the openings in the frames to allow for expansion joints hidden by quarter-round molding. The upper panels are composition board on which old maps, decals, or other suitable decorations are applied and given a protective coat of clear varnish. Bevel solid stock for the lower panels, which can be made up from two or more edge-glued boards if stock wide enough for the opening is not available. Stain and varnish the wood frame before fitting top panels.—H. R. D.

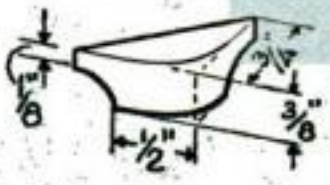
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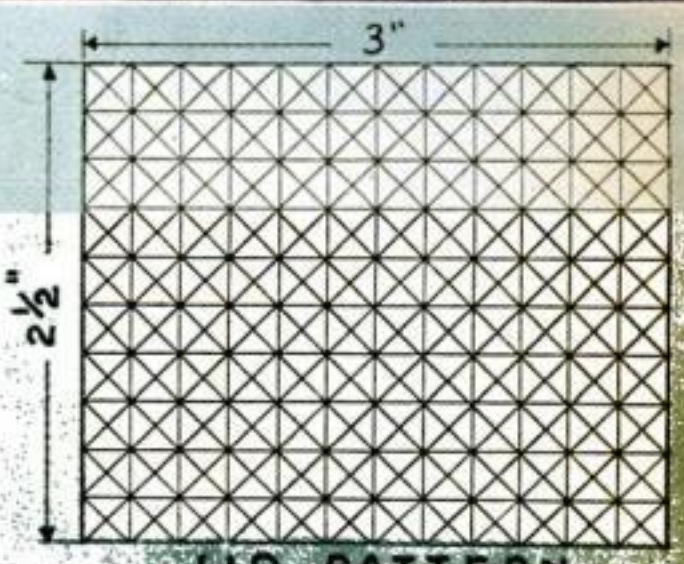


FRONT PATTERN



FOOT DETAIL
(4 REQ.)

CHIP-CARVING
PATTERNS
(¼" SQUARES)



LID PATTERN
LAY OUT ON CURVE

Treasure-Chest Book Ends

DOUBLE AS UTILITY BOXES

CHIP-CARVING beginners will enjoy this project. If carefully laid out, the carving itself is elementary enough, yet the result is a pair of rich-looking chests that not only serve as practical book ends, but are also sufficiently roomy to hold cigarettes, cards, and other small accessories.

Black walnut is a good wood to use, since it lends itself to a fine finish and since it is heavy enough to support books securely. Lay out the patterns on the front and top, remembering that the one for the top follows the curve, and cut the V-shaped grooves with a small, straight chisel. Then dado the ends to receive ⅛" fiber board or similar stock for the bottom, drill undersize holes for the escutcheon pins that hold on the copper strips, and assemble with glue.

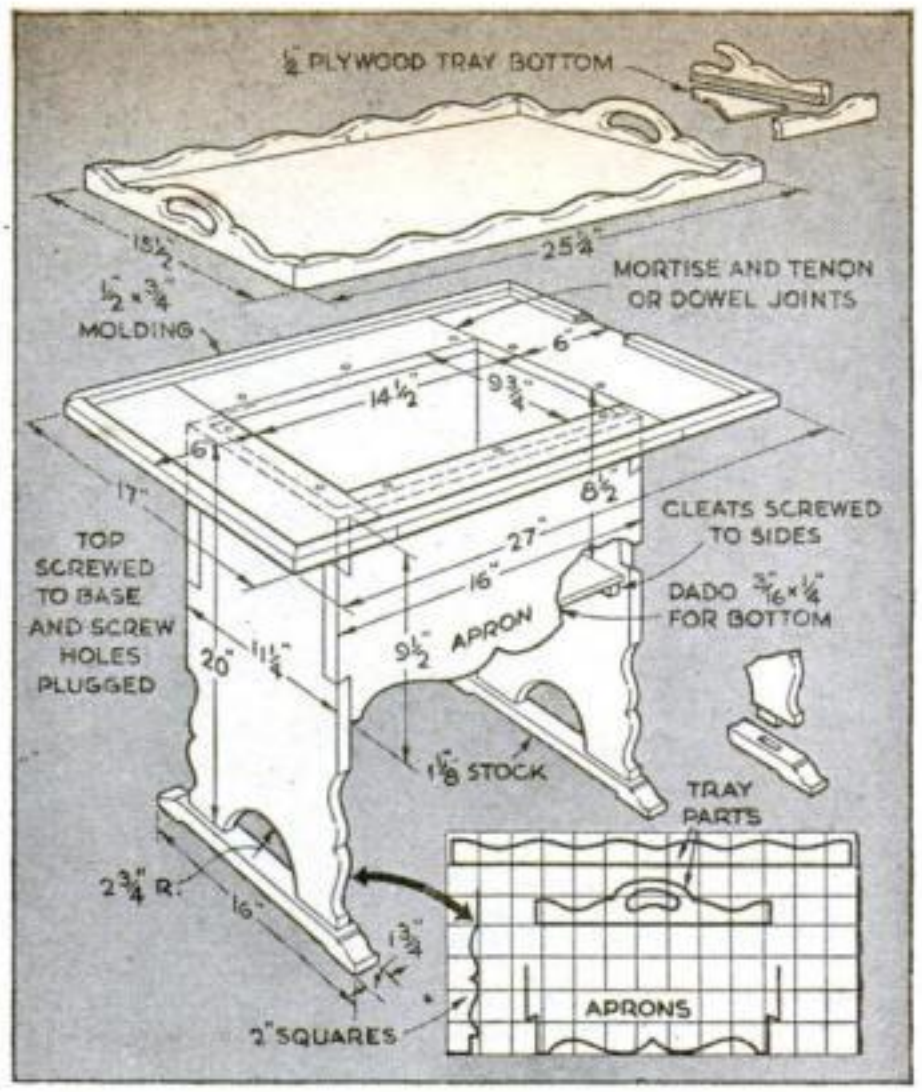
Before putting on the copper strips, sand the corners round. Do the same with the feet and the lid, and then take the sharp corners off all exposed places with light sanding. The inside of the lid may be hollowed. Attach with small brass hinges.

An effective finish for the wood can be obtained by three applications of oil, rubbed in well. Polish the metal until it gleams and coat with clear lacquer to prevent tarnish.

The cleat between each box and the uprights behind it is wide enough to permit the hinged lid to be fully opened. If the thickness of the lid is increased, be sure to increase cleat thickness.—A. ARMSTRONG.

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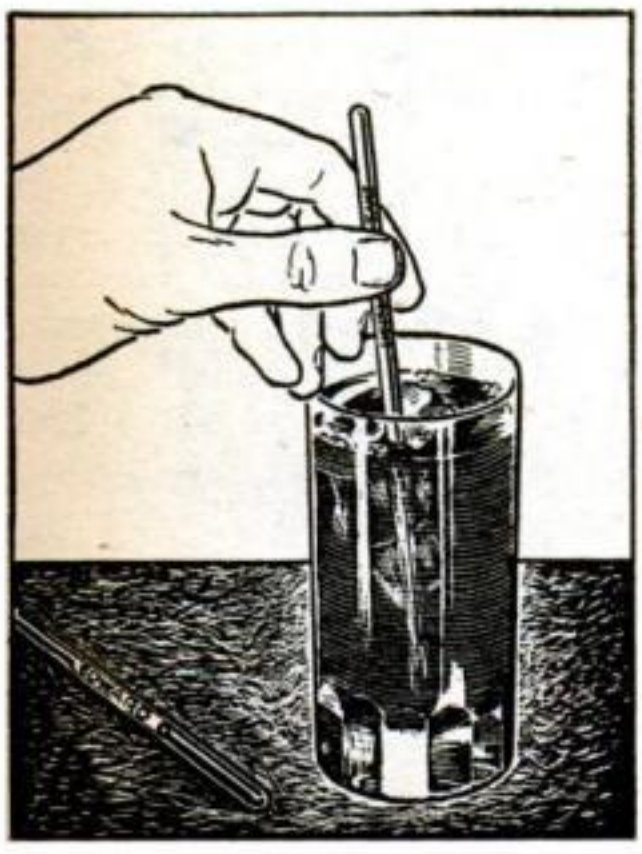
Small Early American Tray Table Has Built-In "Wine Cellar"

THIS small tray table is really a miniature Colonial "hutch table" with a removable tray top. When the tray is lifted off, a deep well in the table provides storage for bottles and glasses or for games, sewing materials, and the like. The larger piece from which it was copied had a hinged top, but it also had the hutch, or chest, for storage below the lid.

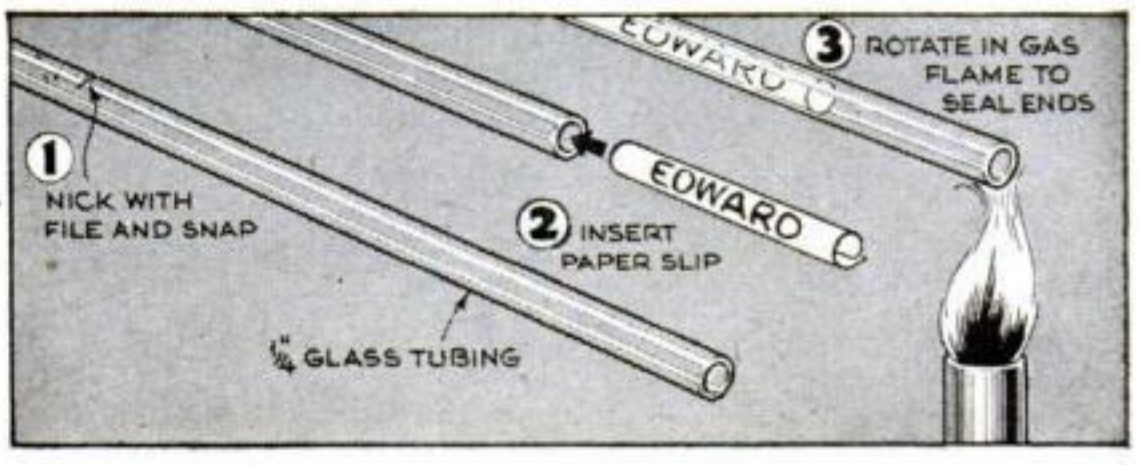
All parts of the table are constructed of ¾" white pine except the feet, which are 1⅛" by 1¾" pine, and the well bottom, which is 3/16" plywood. Lay out 2" squares on the stock for the ends and aprons, and then transfer the curves shown in the drawing.

The tray is made of maple with a bottom of veneered plywood, or of ordinary ¼" plywood or hard-pressed composition wood if it is desired to apply a print or an old map to the bottom as decoration. Curves for the four pieces forming the rim of the tray are also given in the drawing above and are likewise transferred to 2" squares on the stock for jigsawing.—HENRY R. DIAMOND.

Personalized Beverage Stirrers Marked with Name on Inside



INDIVIDUAL sets of beverage stirrers can be made from small glass tubing cut to 6" or 7" lengths. Print your name on slips of white or colored paper, insert a slip in each tube, and close and round the ends in a gas flame. When you are preparing for a party, the names of guests can be inserted, and the rods then presented to them at the end of the evening.—ERIK H. DUFFY.



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ALPHABET BLOCK TRAIN



BLOCKS have stepped out of the toy class. Given special shapes, they can be used to teach as well as amuse young children. The set illustrated above, for example, has dovetails locking the blocks into a train that can be snaked across the floor or even swung through the air. If all the joints were alike, it would merely be a simple toy; but if you shape each dovetail differently so that the train fits together only in proper alphabetical order, it will help teach a three-year-old the alphabet. Numbered blocks could teach him to count, and other sets might be made for anything else a child must learn in sequence, from script or lower-case alphabets to U. S. Presidents.

Construction of the alphabet train requires only a coping saw, some wood, and about an hour's time. Use hardwood approximately 1″ thick, 1½″ wide, and 39″ long. Mark the board into 26 1½″ pieces and saw them out, following the principles suggested above. After sanding, paint and letter the blocks in the bright colors young children like. For the proper snakiness, the blocks should fit rather loosely. Use a thick blade in the saw and, if necessary, file down any surfaces that prevent the train from bending. The dovetails must grip firmly, however, so that the train will not fall apart easily, and they must be strong enough to withstand the inevitable rough handling of pre-school children.

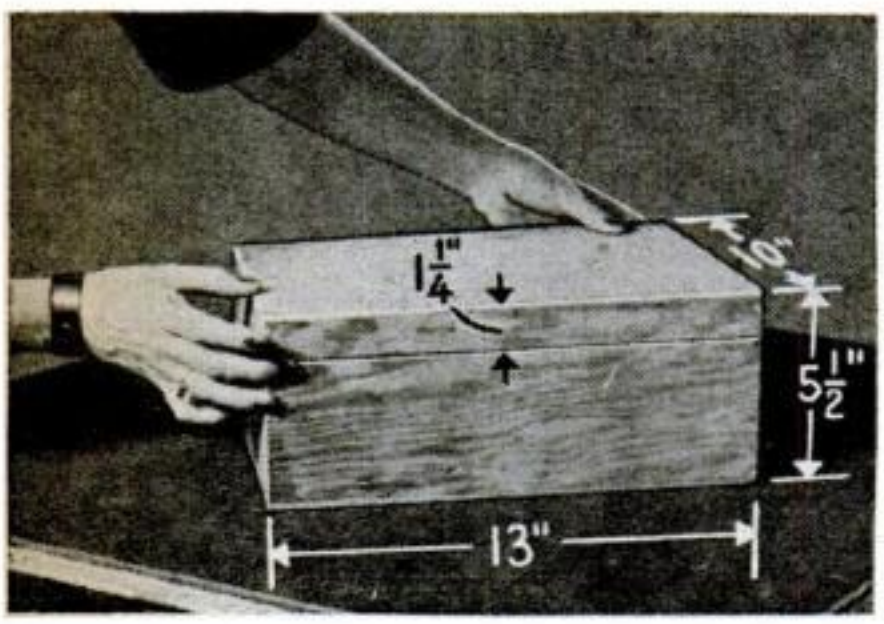
Since the alphabet can seldom be taught easily to a child younger than three, two-year-olds will get most benefit from the simpler number train. Make this set in the same way as the alphabet train, but considerably larger, using wood 1½″ thick, 3″ wide, and 30″ long. Cut into 3″ squares, and this time shape very distinctive dovetails for simplicity.—STUART HOYT.

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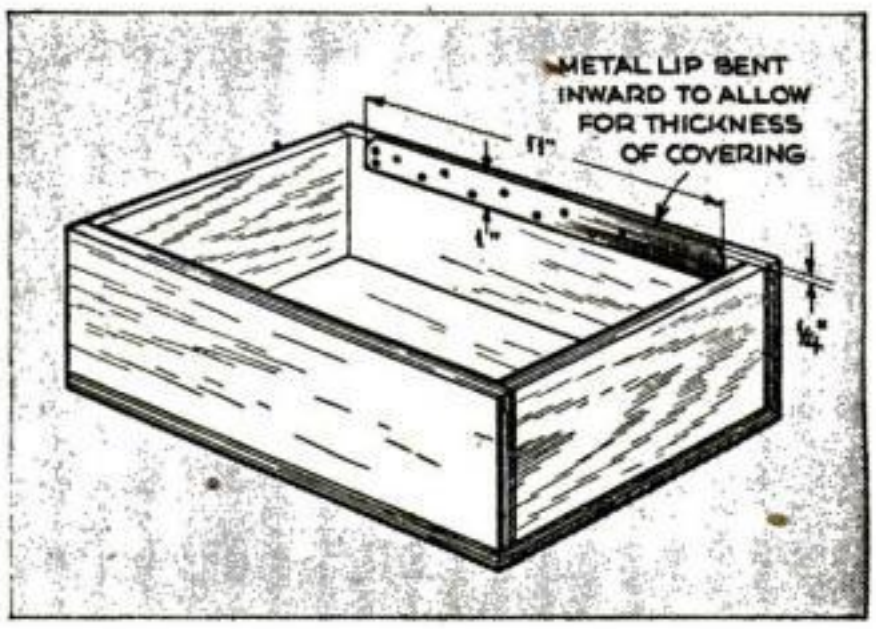


LEATHERETTE-COVERED OVERNIGHT CASE

BY CHARLES M. RICE



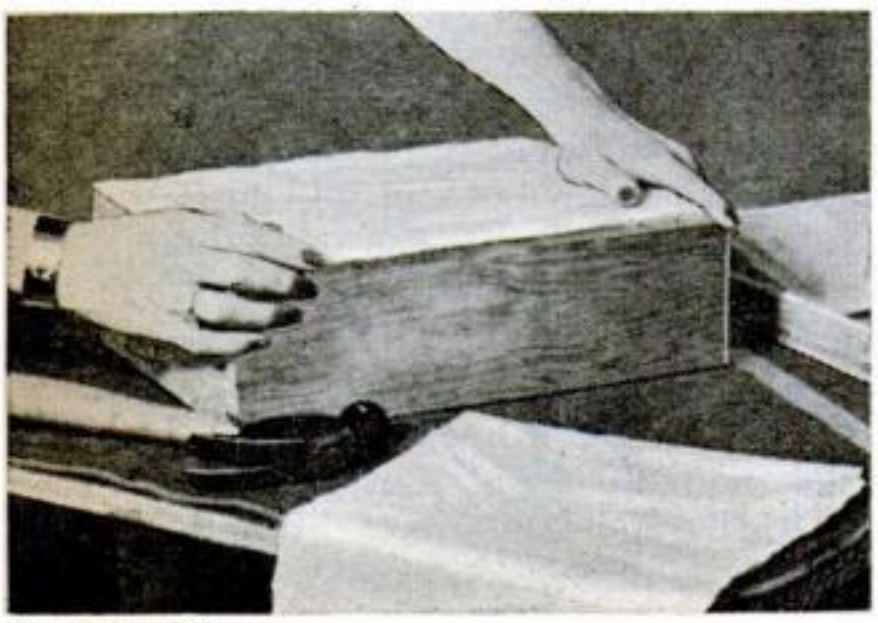
1 Plywood ⅜" thick is the base stock. Make it into a box held with waterproof glue and brads, first marking the pieces for sawing off the top so brads won't come in the way.

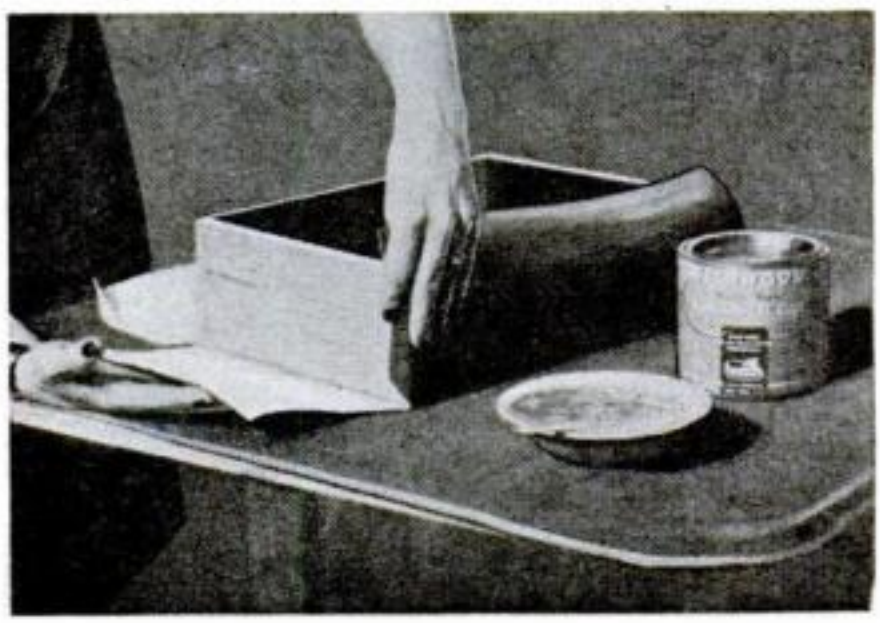


2 Drill a metal lip for screws, attach it to the inside of the bottom as shown, and then bend it back a little so that the covering on the top will pass. Sand the box corners round.

5 Cotton sheet wadding is cut slightly undersize and glued to the top and bottom only. Allowance must be made for the padding when the pattern for the covering is laid out.

6 Stretch the covering over the wood on tacky glue. Press it into the corners at the lip, slit at the miter angle, and continue stretching. Pinch the lip ends. Sand them smooth when dry.





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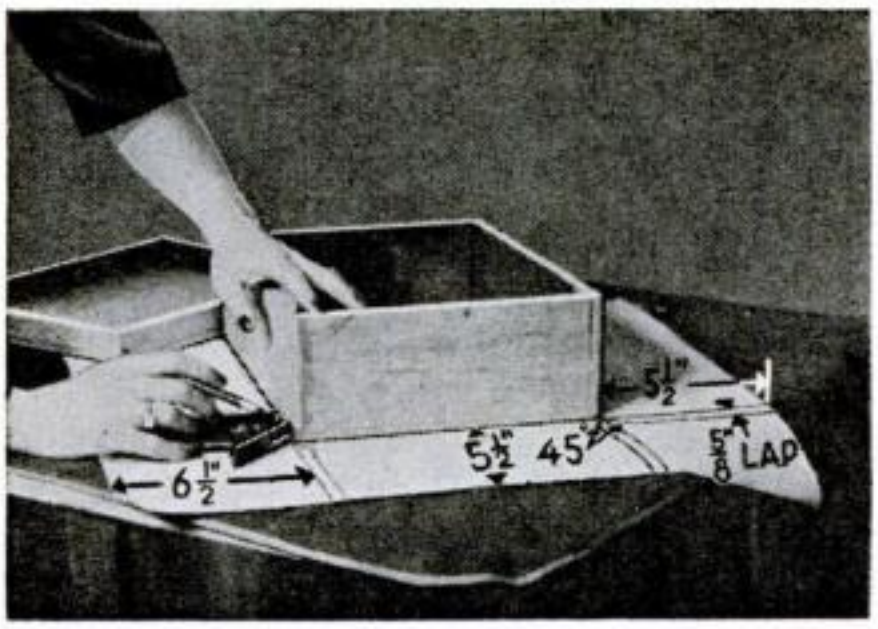
CRAFTWORK for CHRISTMAS

RICH-LOOKING luggage appeals to everyone, but often the price is prohibitive. Here is an overnight case that you can make yourself and carry with pride. It is handsome and sturdy and has the appearance of a luxury item, yet it can be made for less than the cost of a cheap, flimsily constructed piece.

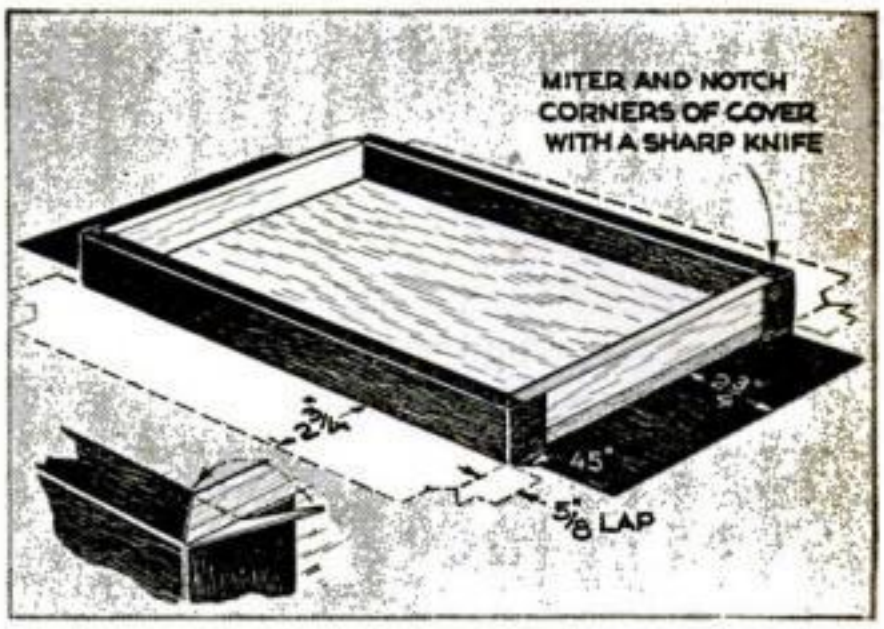
The base of the case is a plywood box, and the covering is a heavy imitation leather. Dull blue was chosen for the case shown here, but upholstery shops carry a tempting variety, and you will be able to find almost any shade you could desire. The lining may be any suitable material to harmonize. Blue satin upholstery with gay stripes in rose and yellow was used for this case. A modern plastic handle and special hinges and a lock were obtained at a luggage-repair shop.

When laying out the patterns for the covering, it is a good idea to tack the cotton padding in place with spots of glue at the corners first so you will be sure to have enough material. Note how the corners are mitered and cut to avoid overlapping on the edges as this would keep the lid from coming down tight all around. Be sure to allow an extra 1″ of material for the front of the bottom section so the metal lip can be covered. Slitting the material near the mitered ends of this lip will enable you to stretch it down smoothly inside. The cut ends are pinched together and later sanded down slightly after the glue has dried.

The case is shown in color on page 112.

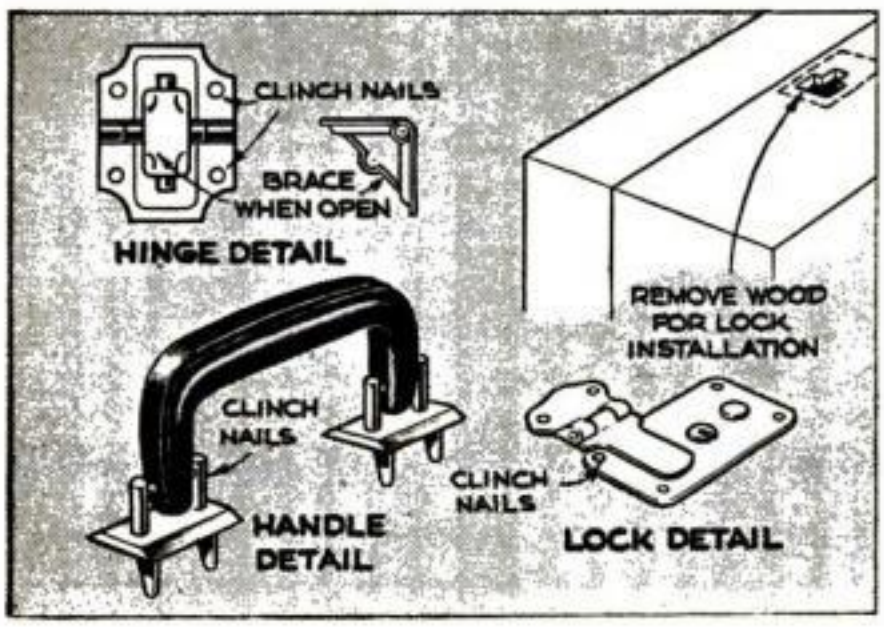


3 Cut a rectangle of covering material large enough to reach inside the box about 1″ and place the box in the center to mark the pattern on the inside face of the material.

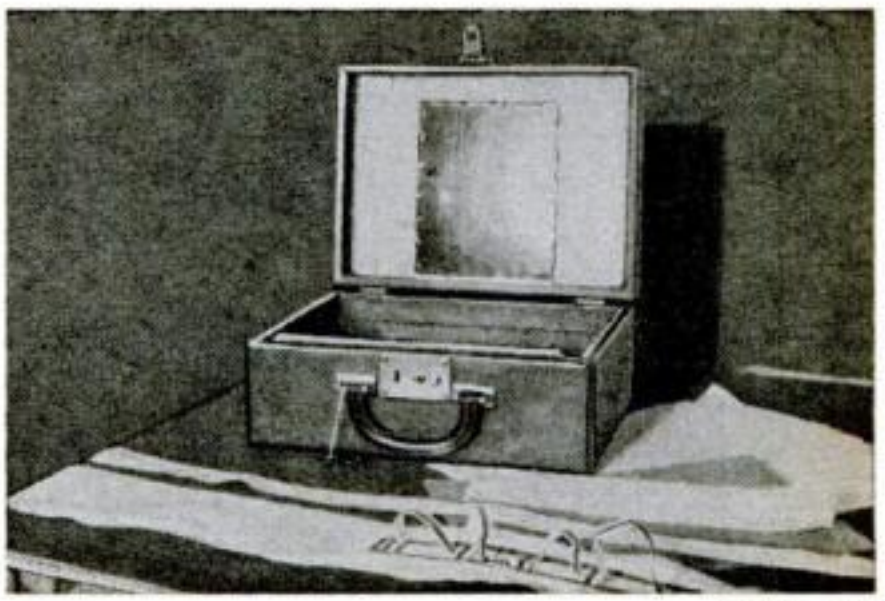


4 Lay out and cut the covering for the top in the same way. So the top will close tight, miter the corners of both pieces and cut with a sharp knife to avoid double thickness there.

7 All hardware is fastened with nails started in drilled holes and clinched. The hinges shown are made especially for luggage and brace the top at a 90-deg. angle when open.



8 Glue lining in loosely over the hinged joint. Line the bottom, sides, and top with material sewed to cardboard and glued. Cutouts are made for the mirror and a tape to hold cosmetics.

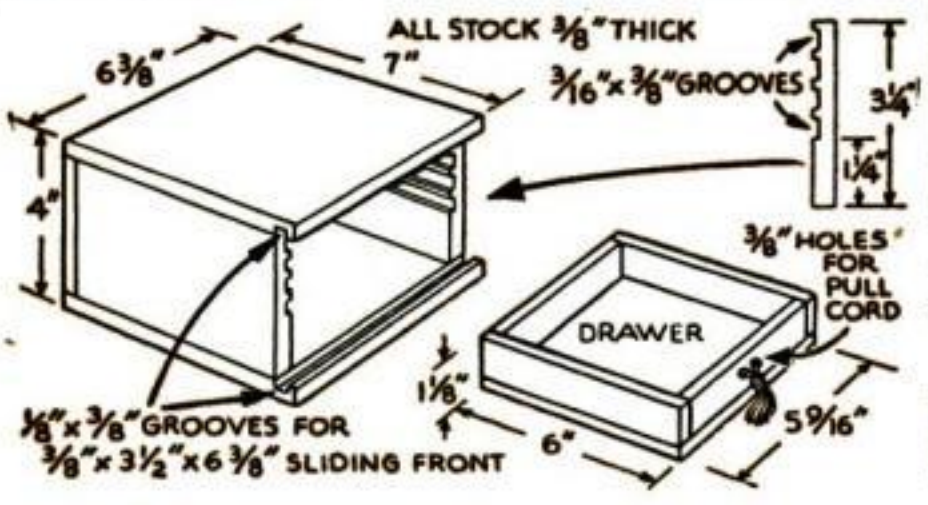


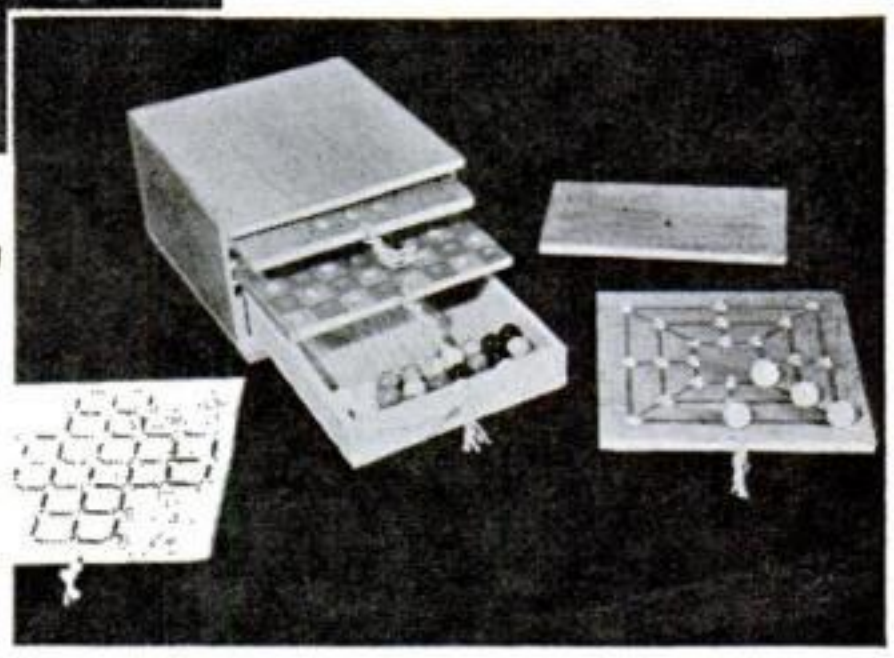
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"CRAFTWORK for CHRISTMAS"



FOUR-IN-ONE GAME KIT





FOUR different games are included in a compact kit small enough to be taken anywhere. Each has its own board sliding in grooved runners. The "men" are marbles kept in a drawer. Make the kit of hardwood.

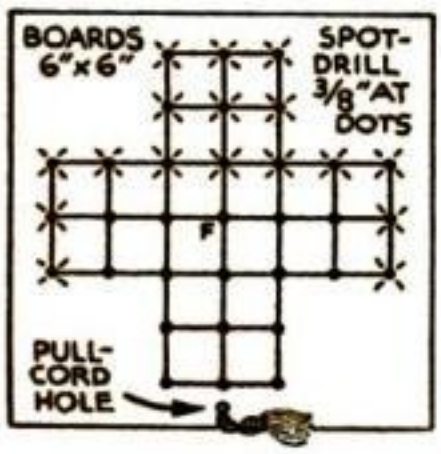
Fox and Geese is an old-time favorite. One player places 17 geese on the board at the crossed spots, and the other has the fox in the middle. Moves can be made in any direction, but only one space at a time. The geese try to hem the fox in on all sides, while the fox attempts to take them by jumping any next to him if there is a vacant space behind. If he fails to take a goose when he has a chance, a captured goose must be returned to a starting point. The game ends when only three geese are left or the fox can't move.

Put a dot of contrasting paint on several checker men. Turn it down until a man becomes a king, and then turn it up.

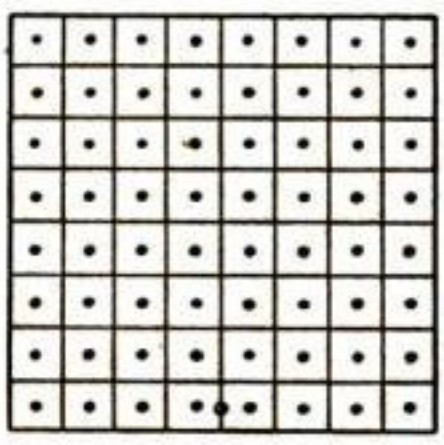
Mill requires nine men, the players alternating at placing them at any point of intersection. Each tries to get three in a line to "close a mill," which entitles him to take any opponent's man not in a row of three, unless there are no others, when one of three may be removed. When all are on the board, men are moved a space at a time. As soon as a player is reduced to three men, he may "hop" to any vacant spot. He is defeated when he has only two men left.

Solitaire is for one player. Cover all but the center hole and jump until only one marble is left. It's fascinating and not as easy as it sounds.—ELMA WALTNER.

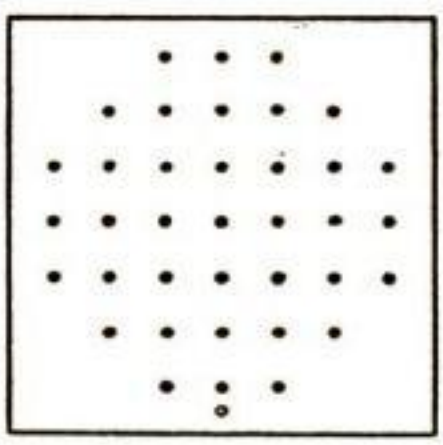
FOX AND GEESE



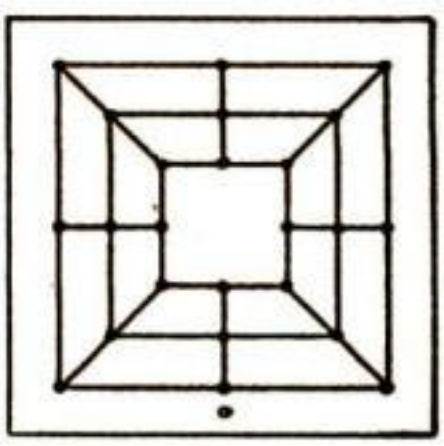
CHECKERS



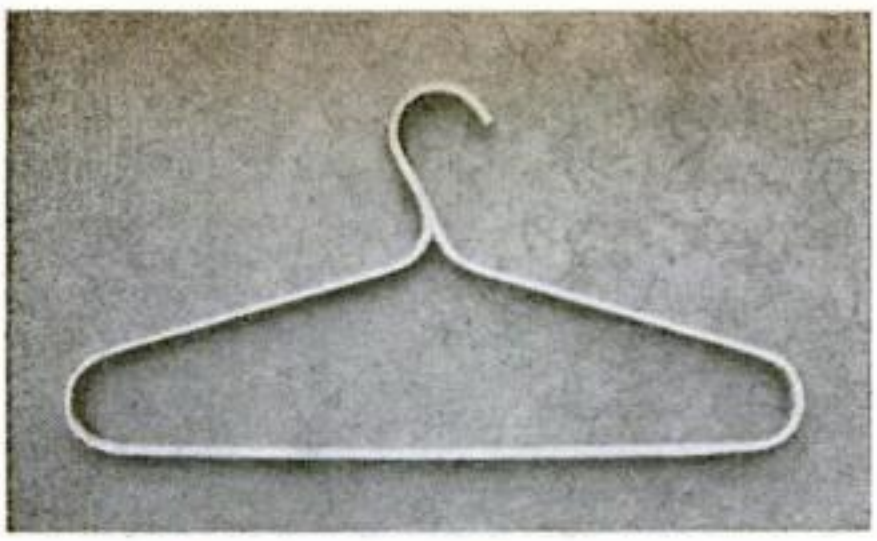
SOLITAIRE

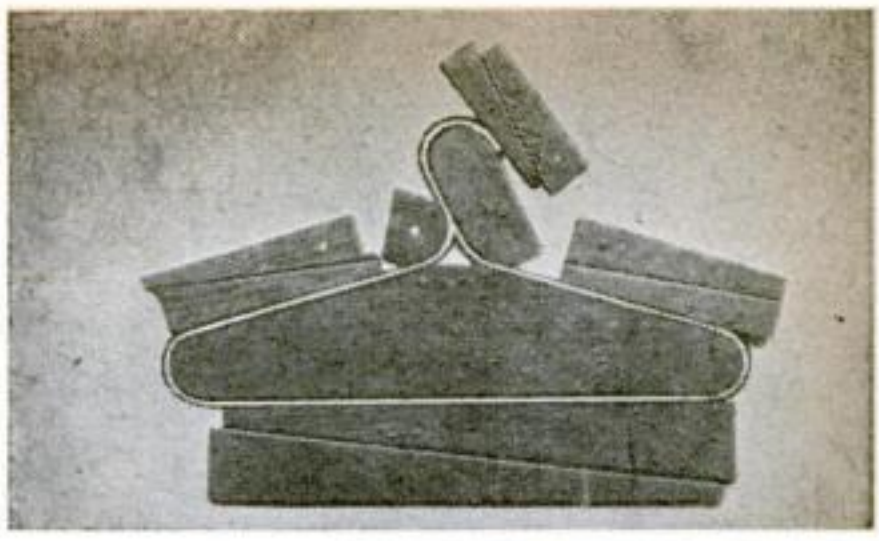


MILL



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Scrap veneer from a crate made this hanger. The jig (above, right) has three shaping pieces — one that forms the body and two for the curved neck—with clamping wedges.

The sturdy plywood bracket at right was constructed of two parts. For the crosspiece, only the simple jig made of two blocks pressed together with C-clamps was needed.



Mold Plywood Yourself with Scrap Veneer and Homemade Jigs

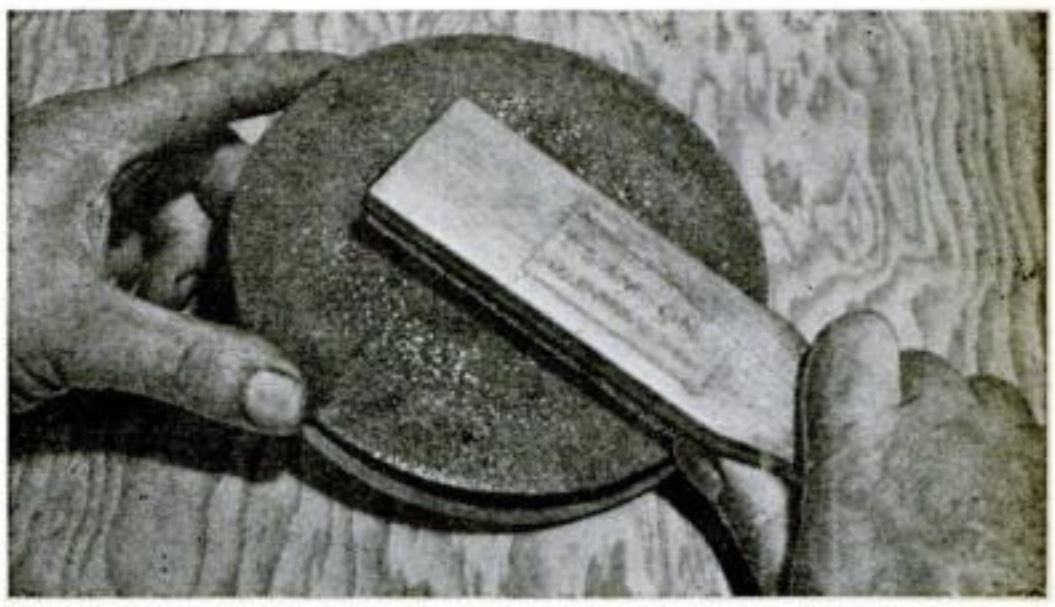
You don't need a shop full of hydraulic presses and other expensive equipment to mold useful, attractive articles from plywood. With only a saw and screwdriver, jigs can be made for shaping drapery clips, coat hooks, brackets, and many other distinctive household items. And scrap veneer will serve as the raw material—the hanger and bracket illustrated were constructed from the sides of an old packing crate.

The procedure is the same no matter what you make. First, soak narrow strips of .050" to .070" veneer in hot water until pliable; 10 minutes should be long enough. Bend two or more strips, depending on the strength required, around the jig form, and lock these veneer layers against the form with the wedges. After the strips have set in shape, they are coated with glue and returned to the jig. Hardwood is used for the forms and wedges. The forms, which shape the veneer, and the outer wedges are screwed to a backing board. The inner wedges are free.—George R. Jones.

Kitchen-Distilled Water

That's money running down the drain every time you pour away the pan of water collected from a defrosting refrigerator. For the water is chemically pure and can be used for any purpose requiring distilled water—to fill a car battery, in photography, or for home chemistry experiments.

In a refrigerator, water vapor that evaporated from food, or was already present in the air, condenses on the coils and freezes, an evaporation-condensation process similar to that used to make distilled water. Catch the melting ice in a clean pan.—Mrs. C. J. Wood.



File Card Cleans Abrasive Disks

A file card will clean abrasive disks of the dust accumulated from cutting soft metal and plastics, improving cutting speed and prolonging life. With the power off, scrub the wheel briskly.—W. T.

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CRAFTSMEN at WORK



MUSICAL INSTRUMENTS made of clear acrylic plastic are a hobby with William Glass, shown above with some of the 12 he has created over a period of years. His work is done at home, the kitchen oven providing the heat to form the plastic.

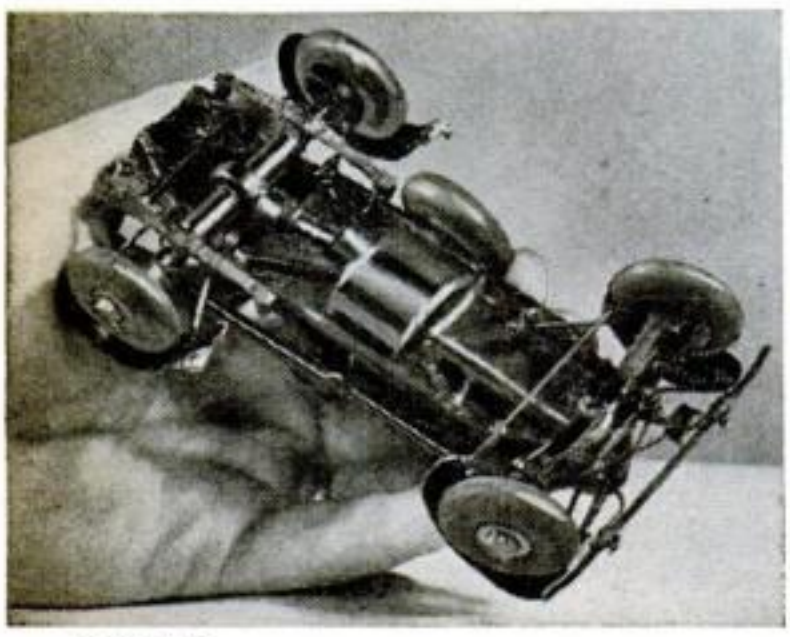


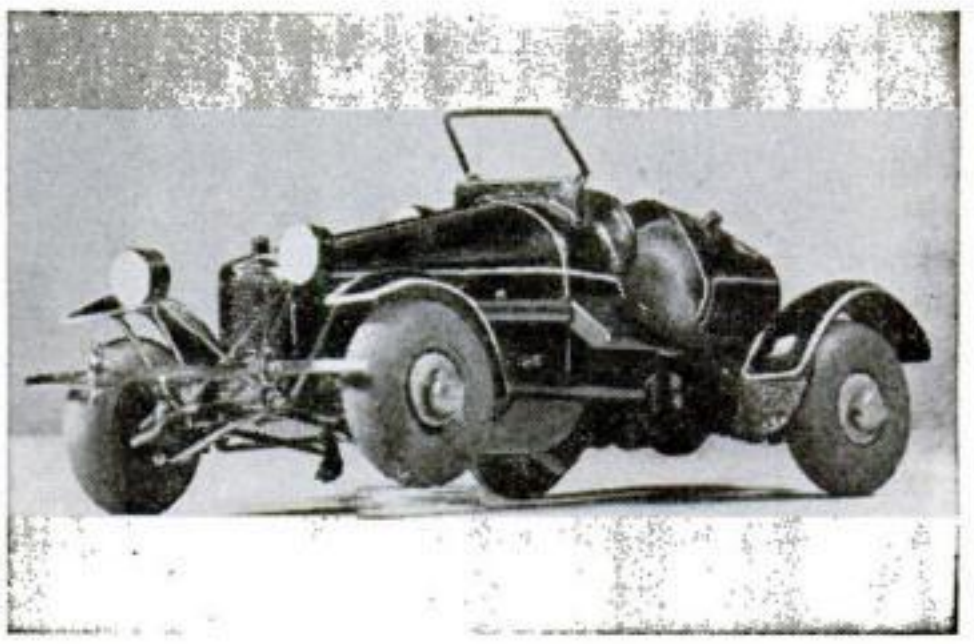
RIDING HIGH, this youngster enjoys the mock airplane rigged up by Richard C. Clapp, of Little Silver, N. J., to slide down a cable stretched at an angle from a barn. There's a safety belt to prevent mishaps and the wheels have knee action to absorb the shock when they touch down.

SEVERAL CABIN CRUISERS built from plans published in a series of articles in POPULAR SCIENCE MONTHLY (PSM, Feb. to May '39) have been churning Puget Sound this year, among them the trim job below turned out by Lawrence L. Ames, of Tacoma, and several friends. The cabin design was changed.



A EUROPEAN RACING CAR was the prototype of this little model. Less than 5" long, it is a product of the craftsmanship of Herbert Lozier, Brooklyn, N. Y. Each wheel is sprung (note the coins in the photo at right below), and the steering wheel has complete working linkage. The motor and transmission are accurately shaped and scaled.





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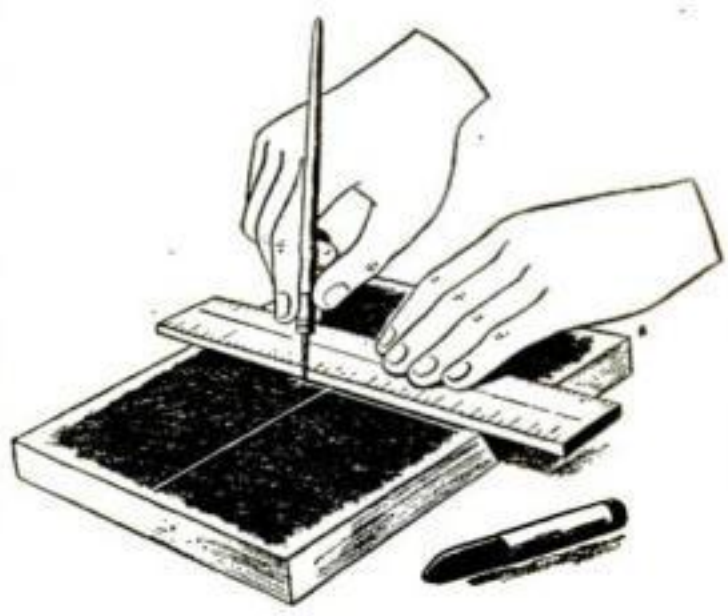
Have you pulled off a smart one lately? We will pay for acceptable contributions showing ingenious solutions of problems in the home, shop, garage, or camp. It doesn't matter if it's wacky—if it works.

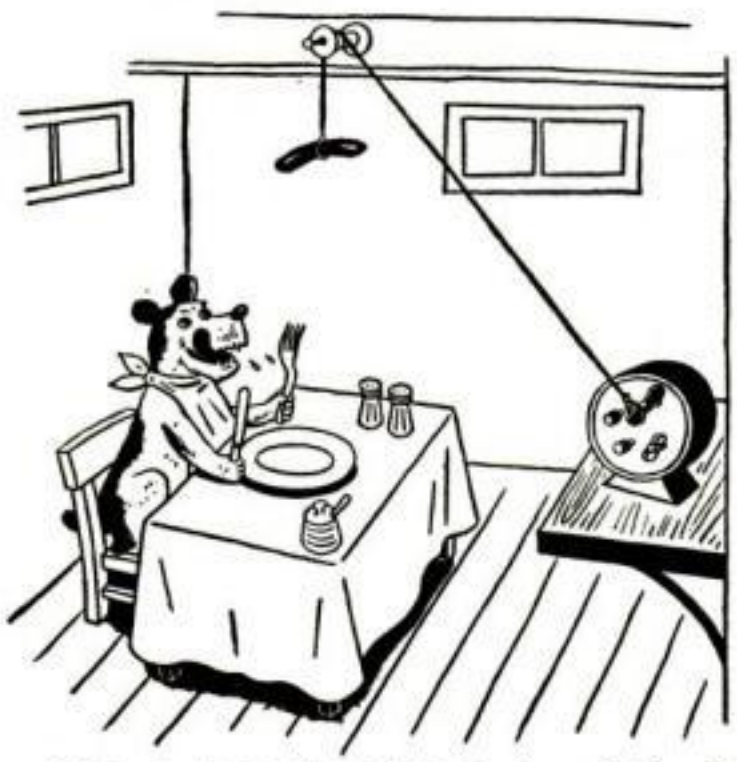
WHAT'S YOUR INGENUITY QUOTIENT? IQ



WAITING BY THE TELEPHONE makes a guy lonely. I don't wait any more, but if I want to find out whether my phone's been busy, I stick two slips of paper—one white, one carbon—between the clapper and each bell. A ring then leaves a permanent and indelible signature on the white paper.—JOSEPH L. COY.

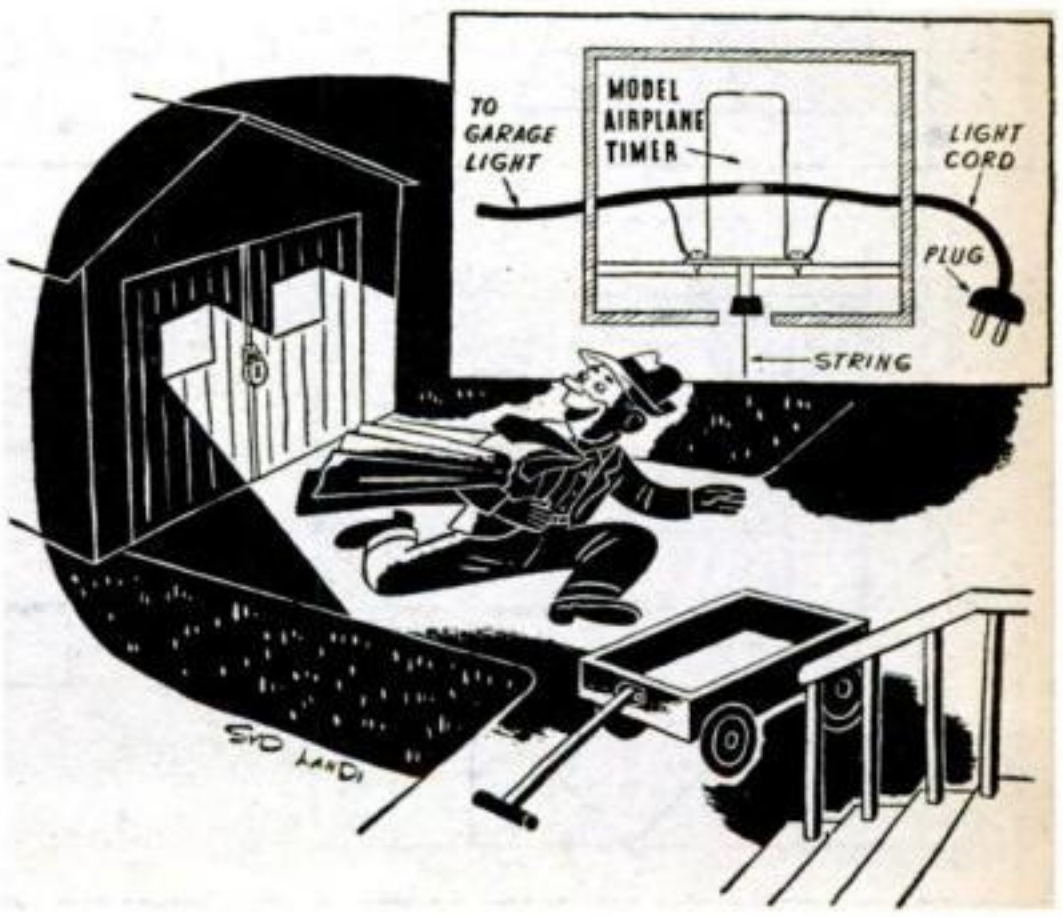
WAX CRAYON, rubbed on brass, aluminum, or other metal surfaces, serves as an excellent base for stylus markings. After the metal has been worked, wipe off the wax with paper and buff the article to a fine finish.—MRS. F. J. HACHT.





IT'S A DOG'S LIFE being left all alone while the family goes out for the day. My pup, Nellie, didn't like it and neither did I, so we worked out a way to leave this dog's hot dogs behind. One end of a string that holds a wiener is looped over a spool and hooked to a clock-alarm key. At dinner time, the preset clock goes off and the precooked picnic comes tumbling down.—P. S. BUSHNELL.

SHOW ME THE WAY TO GO HOME. With the garage light off, our back yard is dark as Dracula's heart. To let me reach the back porch without barking up the wrong shins, I rigged a model-airplane engine timer into the garage circuit. It shuts off the light after I'm in the house. It also gives me light for backing out at night, cutting off the juice after I'm out of the driveway.—STUART ANDERSON.



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Cut It Out!

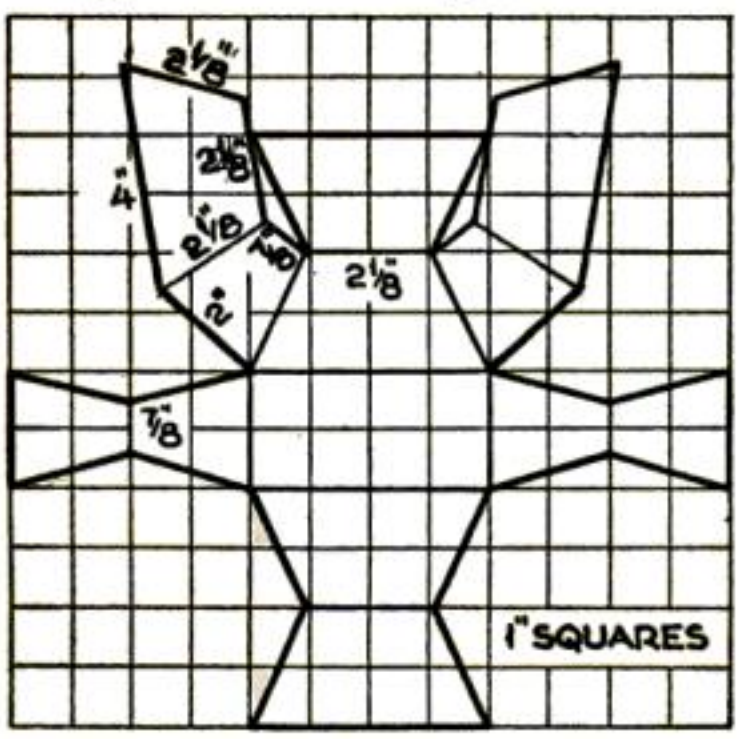
When you say that to the kids on a rainy Sunday afternoon, give them scissors, a pencil, and patterns for these three paper novelties. Then sit back and relax.

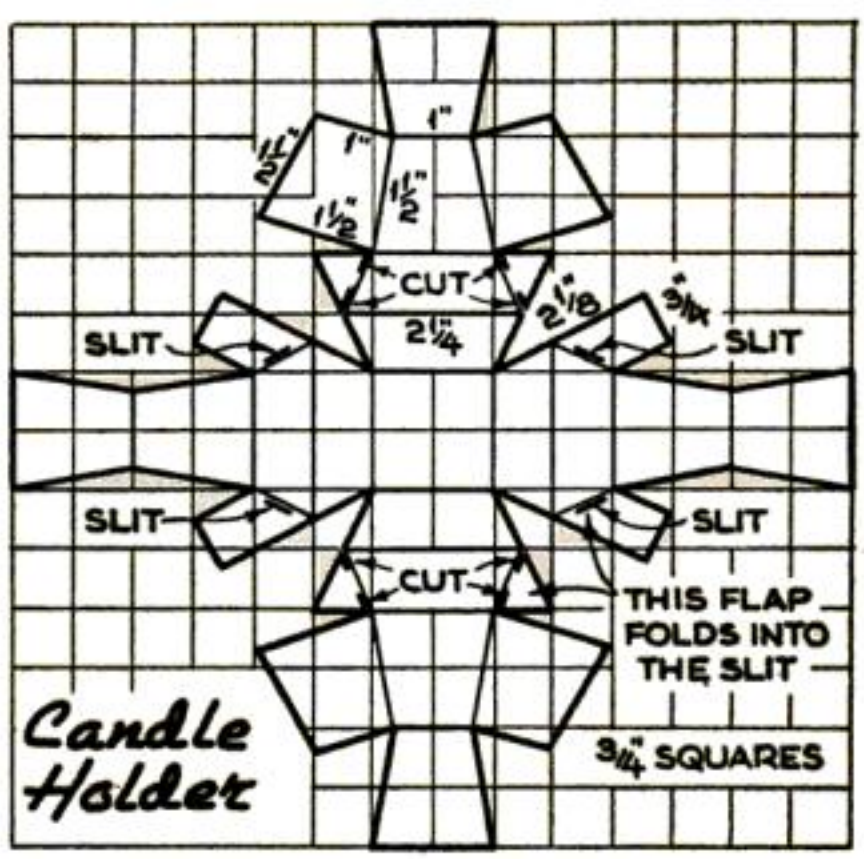
BEFORE you start cutting out paper dolls yourself on what should be a quiet, peaceful day at home, make and cut out cardboard patterns for the pieces shown here. Then turn them over to the children along with some stiff paper, colored if possible, a pencil for tracing the outlines, and scissors. No glue or paste is needed in making the novelties, so there will be no messy table to clean when supper is ready.

All the pieces are folded on the lines shown and interlocked or put through slots as indicated. They are surprisingly strong and can be used as favors when the fun of making them has ended.

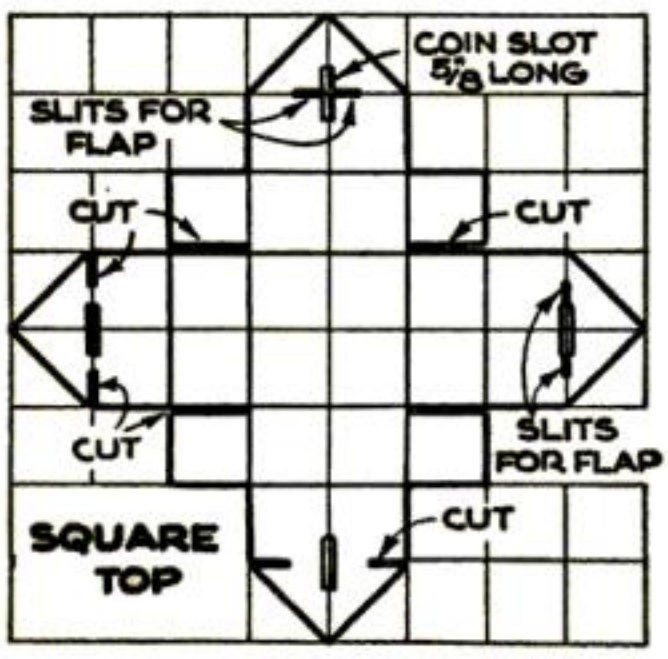
The cigarette dispenser is the easiest to

Cigarette Dispenser



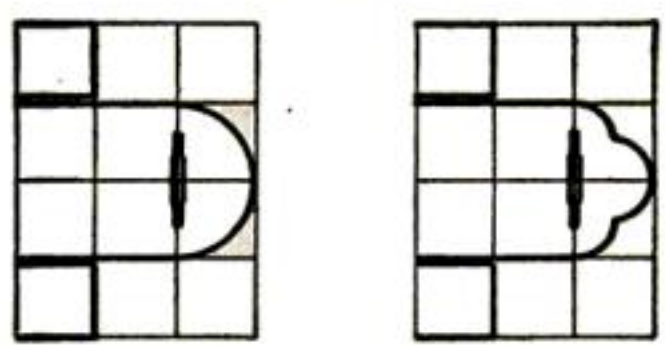


Candle Holder

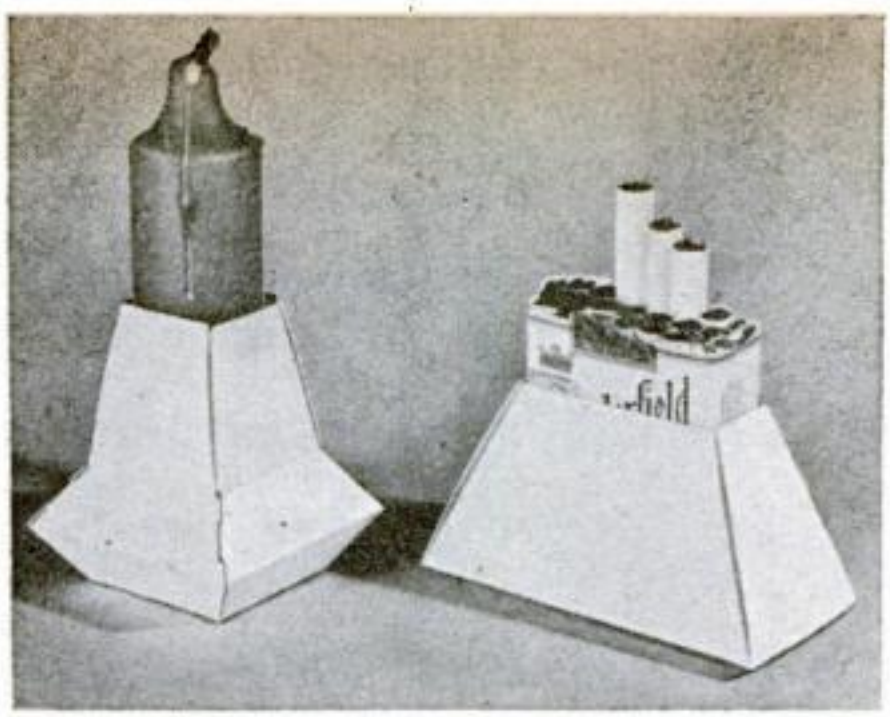


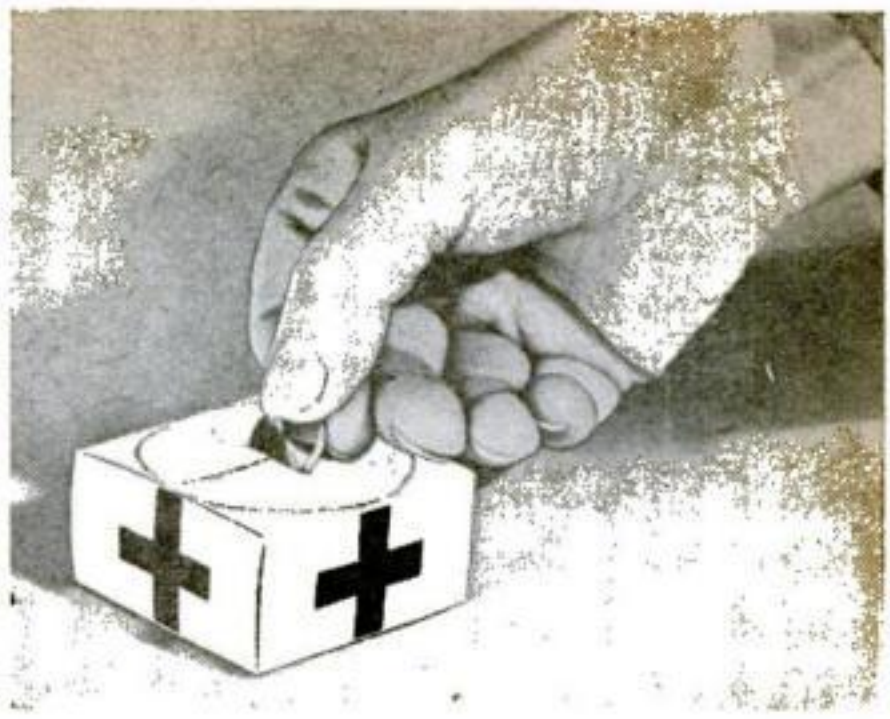
Dime Bank

1"SQUARES



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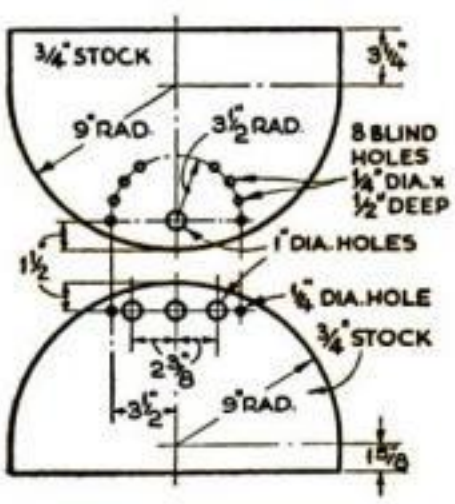
cut and fold. It interlocks solidly without the use of slits. A design painted on it will decorate it for use.

There are no tricks connected with the candleholder. Fold the triangular sections so they will slip through their slots, and then flatten them out again so they remain locked.

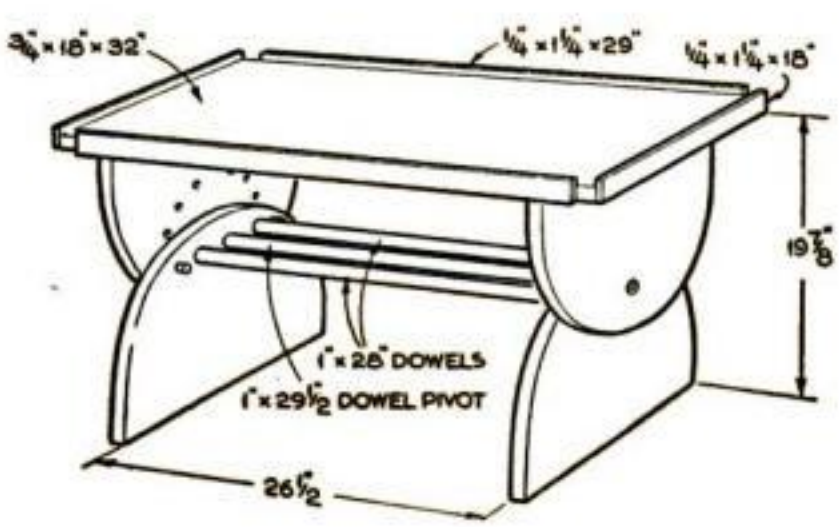
Three designs are given for the top of the dime bank—square, round, and clover-leaf. Patterns for each can be made to add variety. The triangular pieces also fold to go through their slots.—JACK MELLINGER.







Pegs through the lower members of the table hold the top level or at any desired writing or drawing angle.



Coffee Table Useful in Sickbed

MADE of ordinary lumber and three dowels or broomsticks, and then given two coats of enamel or lacquer, this combination table has a use in almost every room in the average small apartment.

In the living room, it is a coffee table. Its tilting feature employed, it can be set up on a kitchen table and used as a drawing board. The stretchers should be high enough to clear a person's legs so it can be used in a sickbed with the top level or inclined.

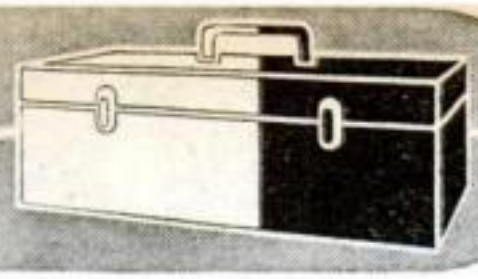
Make the four rounded ends first, taking care to get them all alike; then drill three stretcher holes with the bottom pieces clamped together and drill a hole through for the middle stretcher in each upper member. Glue the outside dowels in the lower member and glue the middle dowel only in the upper member, leaving it unglued in the lower piece so it will serve as a pivot.

Drill the peg holes in the lower member and those in the upper only after the table is assembled. Stop those in the upper piece so they won't show from the outside. Use the lower peg holes as guides and tilt the table at desired angles before drilling the uper ones.

The open corners in the ¼" by 1¼" rim are to accommodate the ends of the head of a small T-square used butted against the inside of either side rim.—GORDON S. GADDA.

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NEW TOOLS

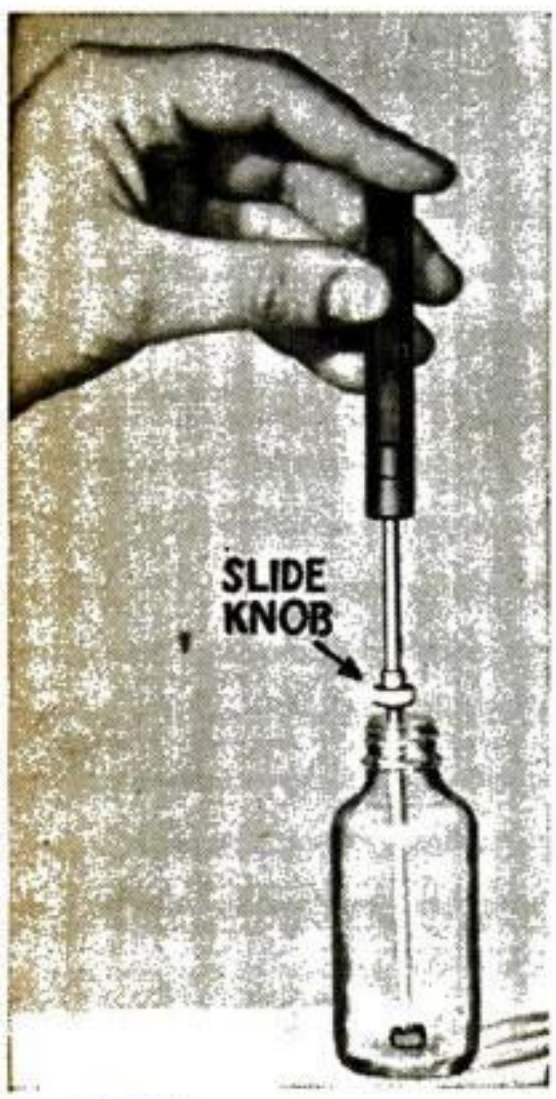


A MULTIPURPOSE GAUGE that can be adjusted to check work as long as 6″ reduces or eliminates the need for large micrometers or numerous fixed gauges. Adjustment for various dimensions is accomplished by sliding the limit ring to change the distance between it and the fixed end ring or the handle. The instrument can serve as a go or no-go gauge: a tolerance allowance of .005″ is ground on half of one face of the limit ring, and an allowance of .010″ is ground on half of the other face. By using two limit rings, tolerances can be varied from .005″ to .020″, report the makers, F. H. Smith Mfg. Co., of Chicago.



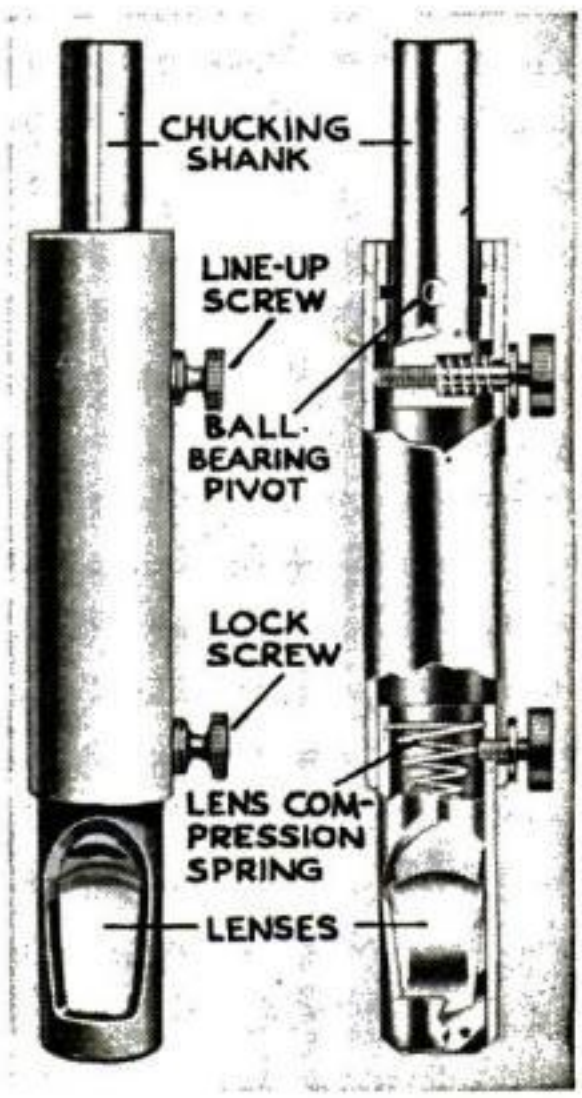


VERTICAL CUTTING OPERATIONS can be performed on a drill press with the new conversion unit shown above. It fits over the drill-press spindle and changes rotary action to a vertical reciprocating movement through a steel roller cam. With only three moving parts, the converter files, cuts, saws, or slots. It can be attached to any drill press within three minutes, say the manufacturers of the unit, the Leo G. Brown Engineering Co., of Los Angeles.

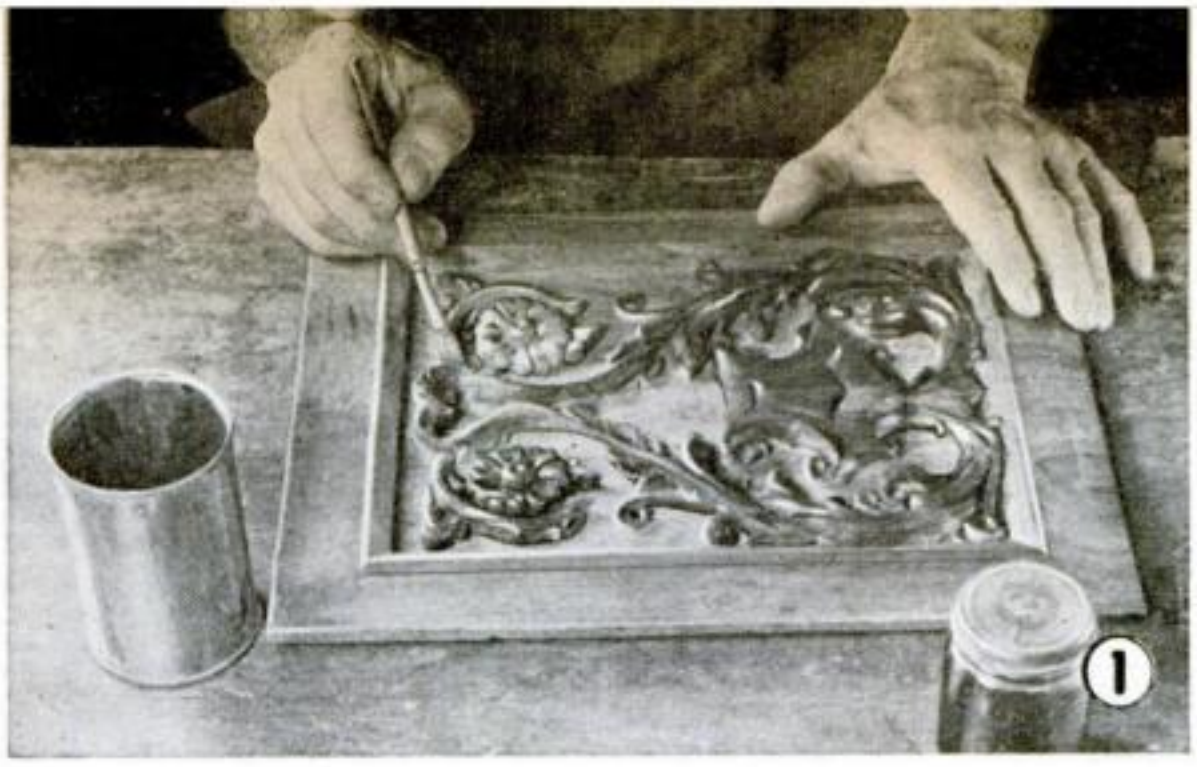


PLACING SCREWS in tight spots is easy with this new screwdriver. The Jiffy-Tite has a split blade that expands inside the slot and grips the screw. Millen Manufacturing Co., of Boston, makes it.

EXACT CENTERING of work in power tools is simplified with an optical sight that fits into the chuck, permitting the machinist to look along the spindle axis and bring punch or scratch marks into line with a reticle. Known as the Opti-Locator, it is made by the Benton Co., of Los Angeles.



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Rubbed Varnish Finish for Fine Carvings

RICH beauty can be combined with lasting protection in a finish for fine wood carvings. Wear-resistant gloss varnish, rubbed with pumice, gives a fine satin sheen that will be superior to the oil-wax finishes that are often recommended but offer little protection to the wood. The result is even better than with flat varnish, which lacks durability as well as richness of appearance.

Here's how gloss-varnish finishing is done. If a colored paste filler is needed—in open-grained wood, for example—prime the raised portion of the carving to protect it against stain, applying four-hour spar varnish thinned 20 percent with turpentine (Fig. 1). Use a ⅜" sable single-stroke lettering brush, taking care that no varnish touches the background.

A thin coat of the filler should be applied to the entire panel, working a section at a time with a stiff brush (Fig. 2). As soon as the filler dries to a dull surface, stop brushing and wipe off the excess with a coarse cloth (Fig. 3), moistening with turpentine, if necessary, to remove smudges. Then clean out the corners with a hardwood pick (Fig. 4). In some places cloth should be used over the pick. Finally, flick off crumbs with a stiff brush, and start filling the next area. In this manner the filler stains the bare wood of the ground without affecting the varnished carving, increasing contrast. When no filler is required, it is unnecessary to prime the carving, since contrast can be secured by staining the ground alone, or by using stain darker than that on the carving.

Let the filler dry several hours, apply the varnish, and follow with a second coat when the first has dried. After this second coat has had 24 hours or more drying time, rub down with a small, stiff brush, using pumice stone and water (Fig. 5). Work systematically from one corner, rubbing all surfaces except sharp edges. Wash off with water when you believe you are finished, and inspect in a bright light to locate any skipped sections. When the entire panel shows a uniform dullness, wash thoroughly to dislodge pumice from all crevices.—E. M. L.







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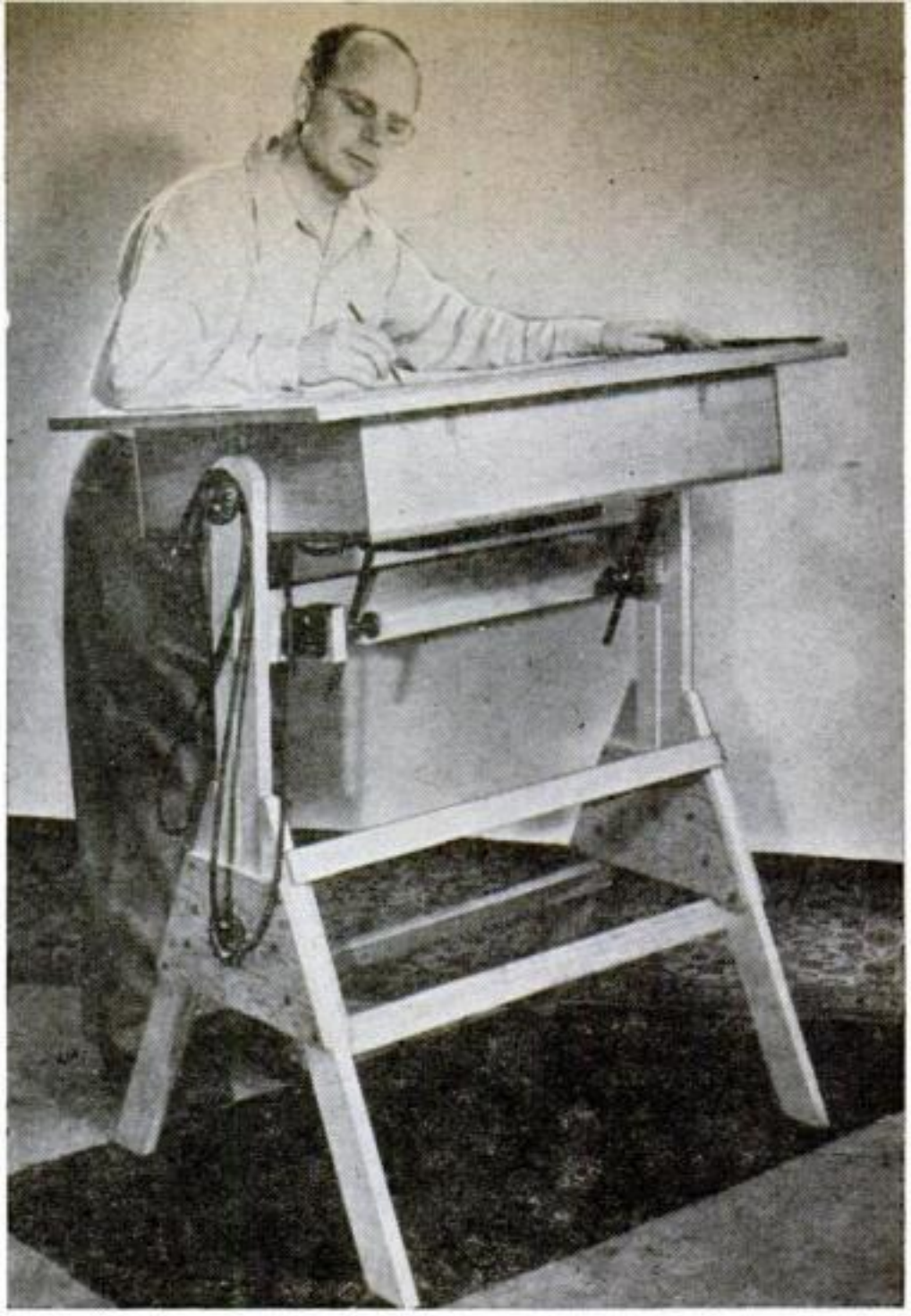


Workshop Drawing Table

I'AS ILLUMINATED GLASS TOP

• • •

By Evan P. Johnson



You'll find your ideas shaping up well as you work on a table like this—a real help rather than a hindrance to clear planning. Its soft interior lighting is restful when tracing. Extended even to full height, the table is solid and steady.

IN MANY shops the single piece of equipment more needed than half the tools on the shelves is an adequate planning table. This one is designed for the craftsman, the illustrator, the architect, and the photographer.

It combines the advantages of a drawing table, tracing table, retouching desk, and negative and positive film viewer. In addition, it provides a shadowless background for illustrating small objects and for making silhouettes. Its large area of soft, white light can serve as an auxiliary light for portrait studies, taking the place of a reflector for filling in shadow detail.

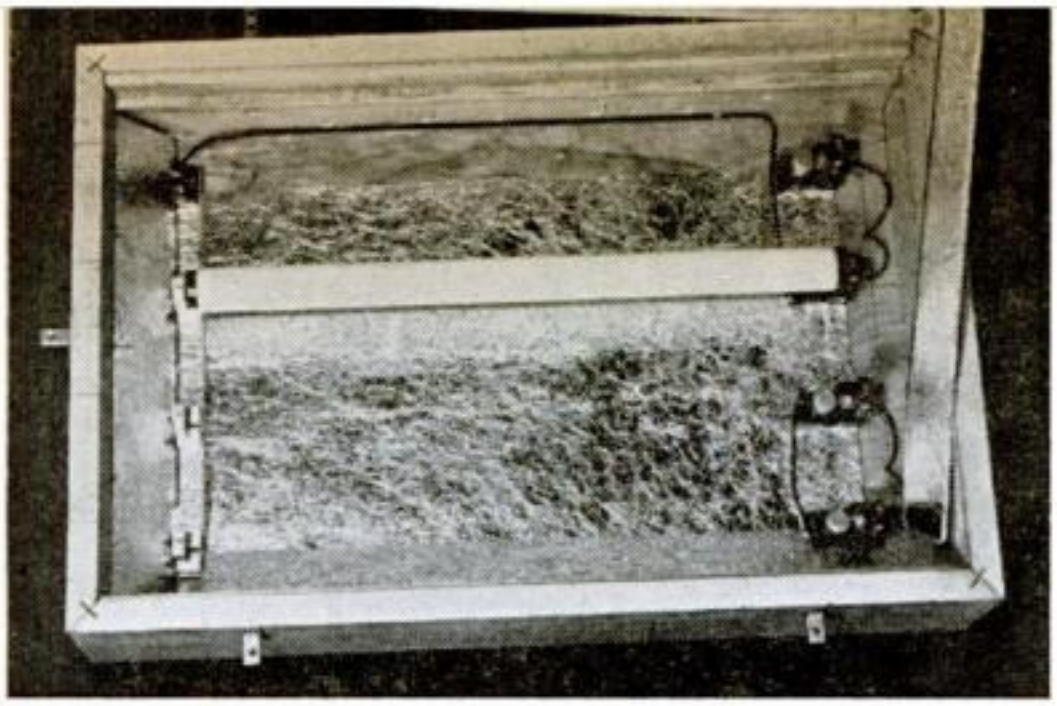
The kind of wood used in construction makes little difference, but it should be well seasoned and free from imperfections. Oak, maple, or other hardwood is best for the base and riser since they take considerable strain. The trapezoid riser guides of the table shown are ½" plywood attached to the legs with ¼" carriage bolts.

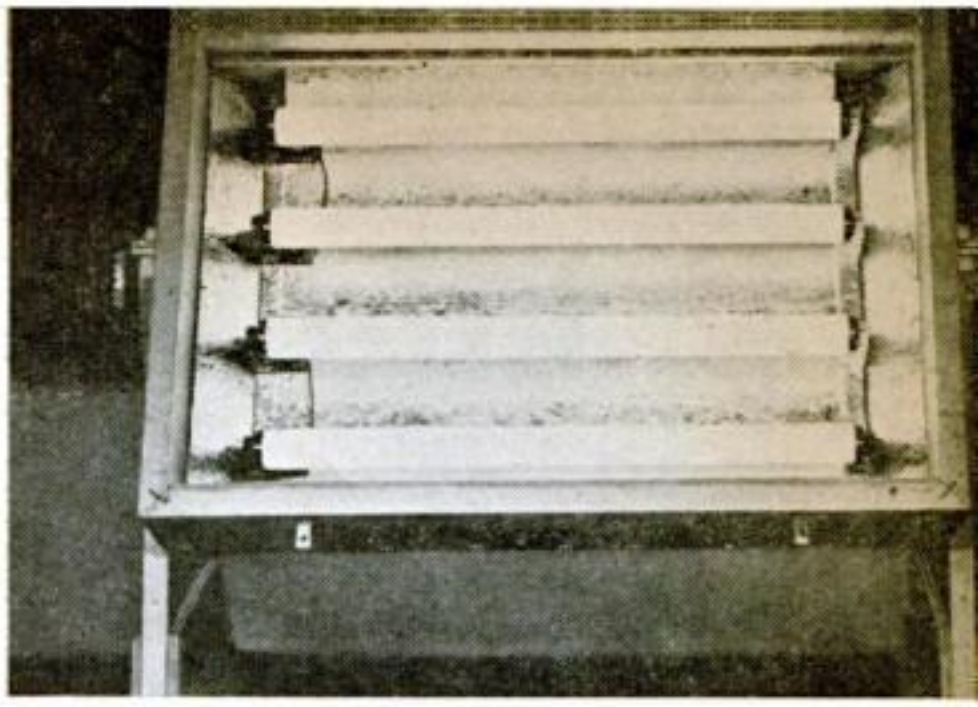
Slot the riser uprights from the bottom to 2" or 3" below the mortise. Assemble on the crosspiece tenons with glue and 3" brass screws above and below the mortises and run the slots over ⅜" bolts in the guides. The riser is locked in position by tightening wing nuts or valve handwheels in which the center has been brazed up, redrilled, and tapped to fit the bolts.

Clear, well-seasoned 1" by 6" pine will make a suitable light box. Miter and glue the corners and draw them together with long joint nails; then glue and screw on a 20" by 30" bottom of ½" plywood, and bore a series of vents near the bottom edges. The dimensions can, of course, be changed to suit needs, but a box of this size has plenty of room to take four fluorescent lamps without danger of overheating.

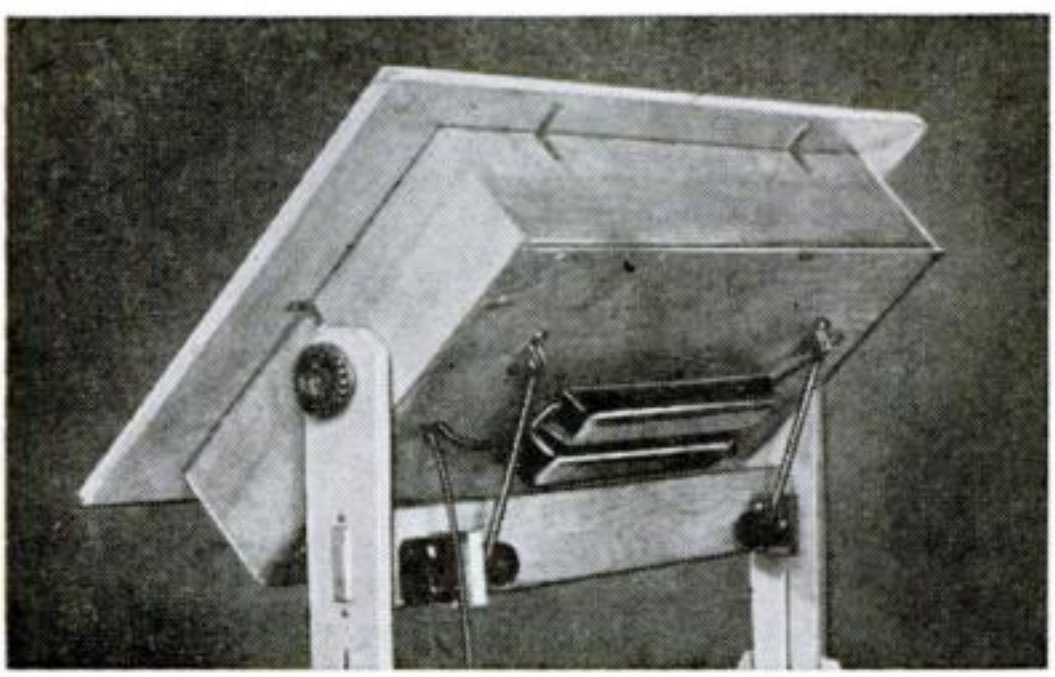
Crinkled metal foil attached to the bottom with rubber cement provides a diffused reflecting surface for uniform distribution of the light, and foil-covered inclined pieces are added at the ends and sides. If foil is not available, flat white paint may be used

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Crinkled metal foil lining the bottom and on four removable inclined pieces at the sides and ends increases reflection. Note the air vents near the bottom in the photo above. The inclined pieces act as baffles over them. Handwheels tapped to take bolts permit adjustment of the table to different angles (below) or heights (right).





instead. Mount the lamps inside the box, screwing the sockets to the bottom, but fasten the ballasts on the underneath side to cut down interior heat. Use stranded wire having rubber insulation heavy enough to stand frequent bending when the angle of the box is adjusted.

Attach the box to the riser uprights with ½" bolts also equipped with wing nuts or tapped valve handwheels. A large friction washer of lead or leather will lessen wear if placed between the wood pieces. Tightening the nuts should hold the box at the desired angle, but some form of adjustable stops may be mounted on the riser crosspiece and the bottom of the box if a more positive support is found necessary.

Two diffusers are desirable over the lamps. Ground glass absorbs little light and is relatively inexpensive. Flashed opal glass is still better, but it is more costly and not as easy to get. Ordinary double-strength window glass can be used if covered with tracing cloth, but light loss will be considerable. Have the glass cut with ⅛" allowance for expansion and support it on ¼" square molding—one glass about ½" above the lamps and the other just below the top of the box. If greater diffusion is desired, interpose a sheet of tracing cloth.

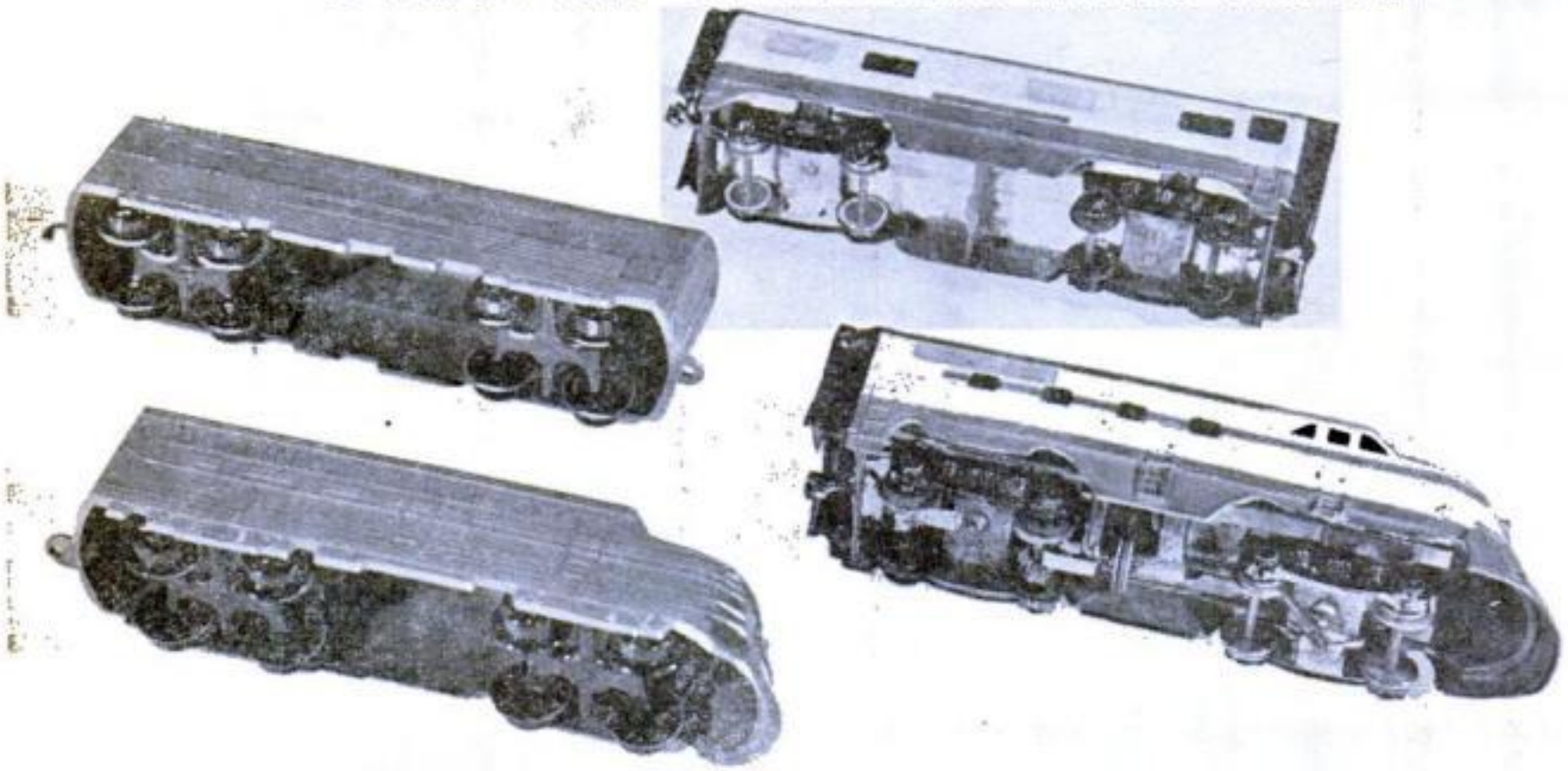
Take care in making the top frame to avoid trouble in fitting in the plate-glass working surface. It may be well-seasoned white pine or plywood and should be at least ¾" stock. Rabbet the inside edges so the plate glass will fit flush or glue and screw on ½" square molding. Mitered and end-lapped corners give a neat appearance. For sufficient strength on the working surface, the plate glass should be ¼" thick. The frame shown measures 24" by 38" and is held to the light box by screws and six small angles. A 20" by 30" glass was used.

While almost any finish will do, a coat of stain and two of rubbed varnish will give the piece a professional look. If enamel is preferred, do not paint the parts of the riser uprights that slide, but wax them instead.

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HO-Gauge Streamliner

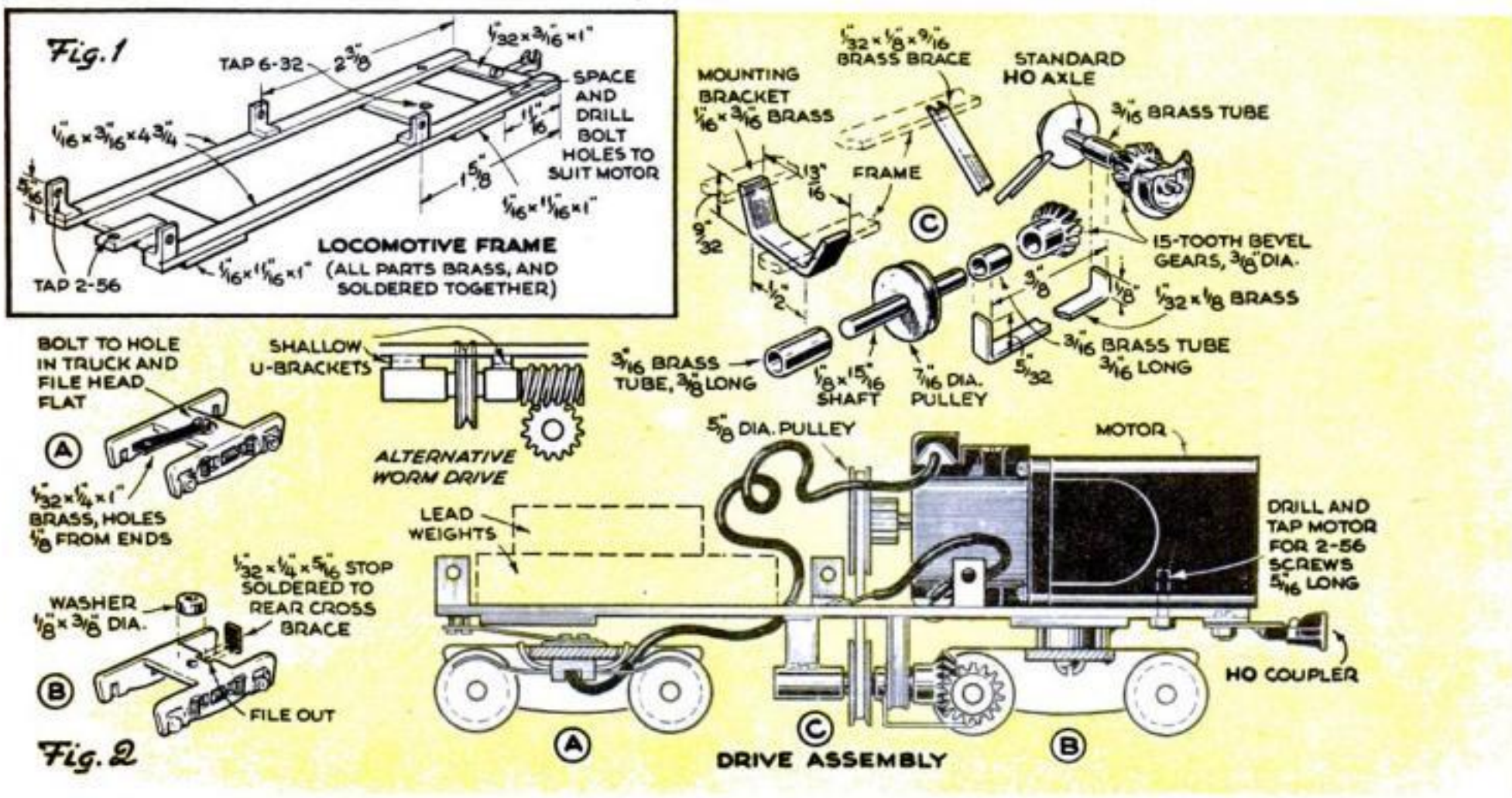
BUILT ON YOUR KITCHEN TABLE



By HERBERT LOZIER

JUNIOR'S traditional Christmas gift, a model train, can be made right on your kitchen table for a few dollars. Plastic toys from the ten-cent store, like those at left in the photograph above, are transformed with motor and truck units, cardboard, and paint into the modern streamliner at the right. Designed for HO-gauge track, the locomotive will pull six cars and climb almost any grade.

Only ordinary hand tools are needed for construction. The motor, drive gears, and trucks may be salvaged from an old multiple-unit car of HO scale, or purchased from a



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model-supply store. The parts needed for the drive are two 15-tooth bevel gears ⅜" in diameter, two small radio-dial pulleys, and a few short bits of brass rod and tubing. Mounting details in the drawings apply to the particular permanent-magnet motor shown and must be altered to suit other types.

Start construction with the frame, which is made of flat brass lengths with cross braces on the bottom and three small angles on top (Fig. 1). Drill and tap all holes before assembly. Then solder the frame together carefully, cleaning off excess solder when cool.

Before mounting the motor, solder the drive pulley to the shaft, using a brass bushing if necessary. If the motor has a gear mounted on the shaft, you can attach the pulley directly to this gear, but make sure it is exactly on center so that it will run true.

Mounting the motor requires two holes drilled and tapped for 2-56 screws about 5/16" long. To assure alignment, these holes should be spotted through the frame while the motor is held beneath it. Set the motor so that the brushes are vertical, with one brush grounded to the frame by a short length of wire.



Next is the drive (Fig. 2). Remove the wheels and axle from one end of an HO passenger four-wheel truck by filing off the bit of metal at the bottom of one side of the truck, just below the axle. Gently tap or twist off the solid metal wheel, being very careful not to disturb the insulated wheel. Once the wheel is off, slip over the axle a piece of tubing 3/16" long. Then solder one bevel gear to both the metal wheel and the axle. Place it carefully so that the wheel spacing will not be changed.

Before returning these wheels to the truck, file a notch in the top plate of the truck on the side still retaining wheels. This provides space for a stop to prevent the truck from moving out of alignment. Now replace the wheels, retaining them with a bit of solder at the points where metal was previously filed away.

Assemble the drive as shown in the drawing, soldering the gear to the shaft, over which goes the small tube. Then attach the pulley wheel in line with the pulley on the motor. Bend and trim the ends of the brass mounting bracket to make the height of the shaft in the long tube match the height of the gear on the truck axle. Solder the bracket to the frame 2½" from the rear and assemble the long tube and shaft to it. Then fasten the short tube to the two brass legs, checking height and alignment. Solder the stop in the notch in the truck and in a similar notch in the rear cross brace; and solder the U-brace to the bearing tubes on the axle and shaft. *[Turn the page.]*

Fig. 3

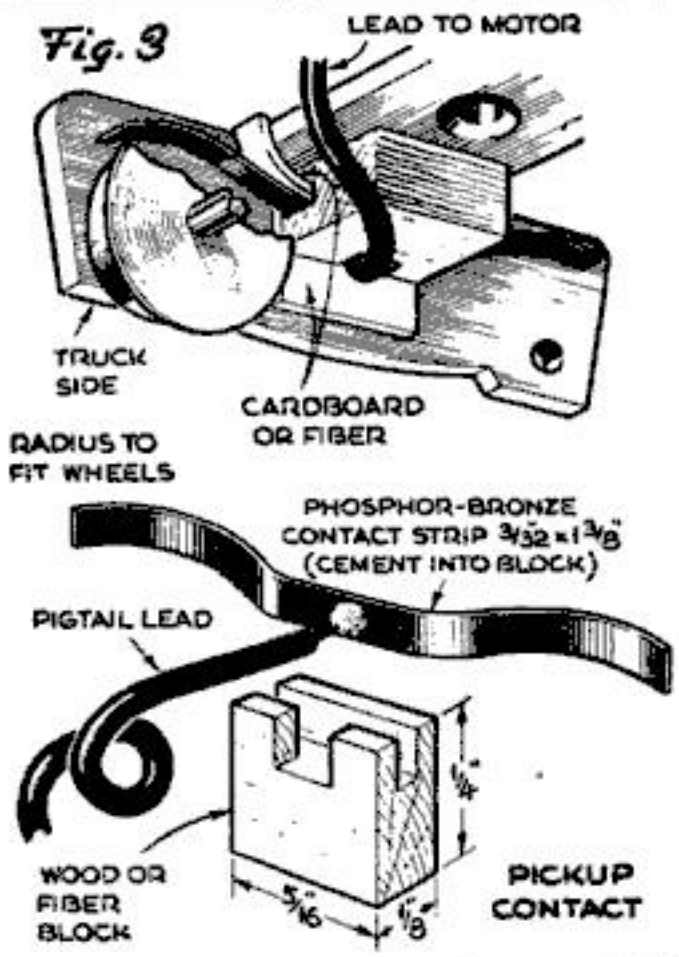
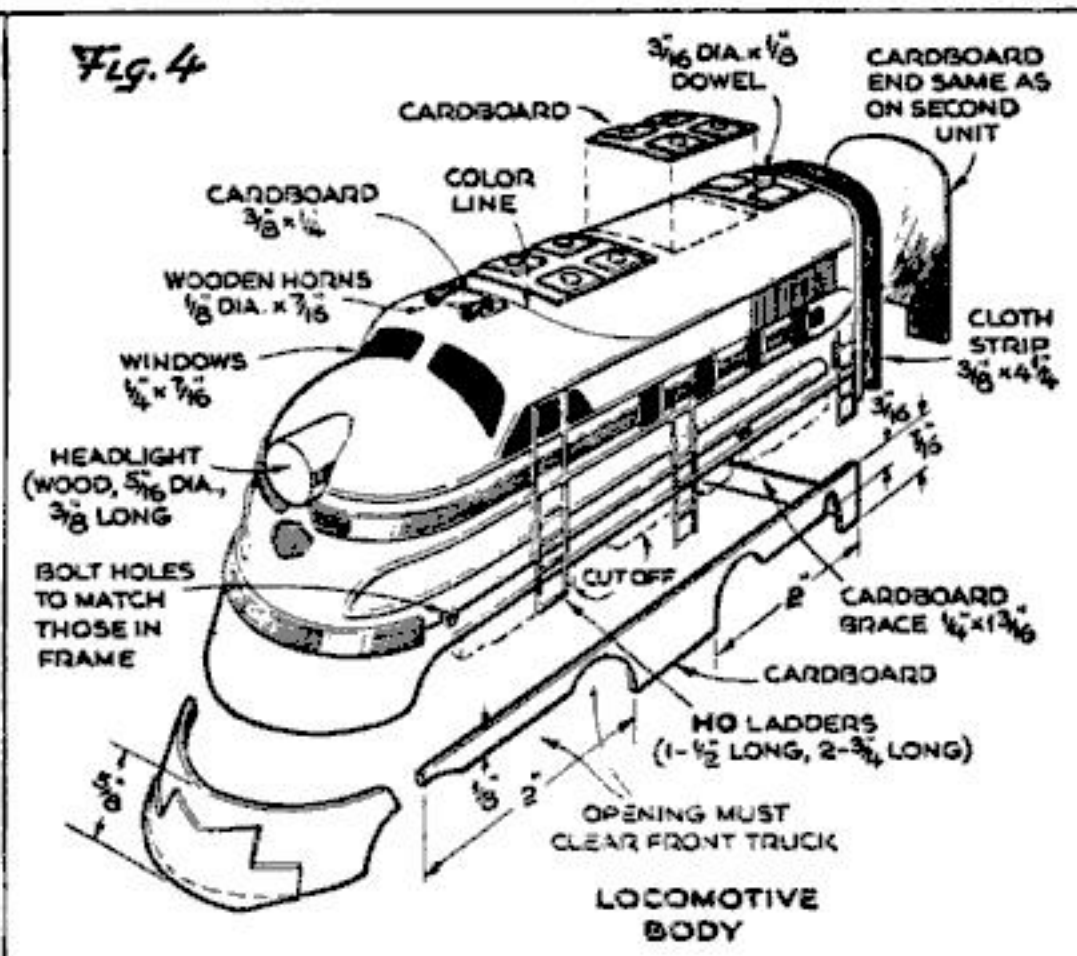
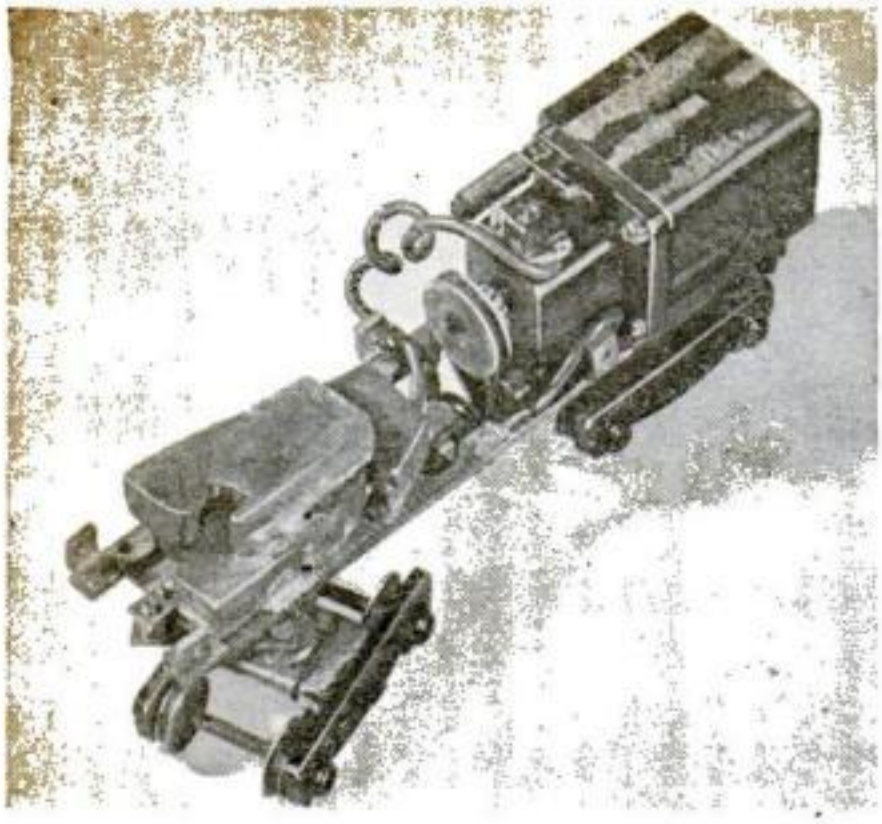


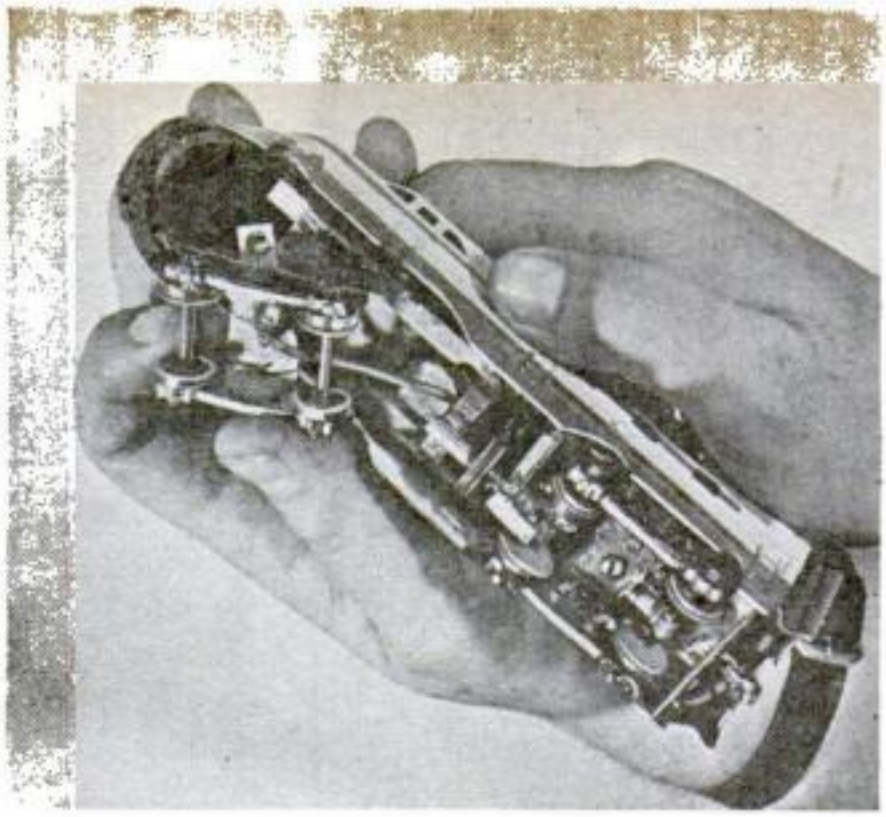
Fig. 4



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Top view shows motor, pulleys, and wire to pickup. Lead weights over forward truck increase traction.



Forward truck, mounted on bar, swings as well as turns. This truck carries the power pickup contacts.

For the drive belt, use a rubber band knotted, cemented, or joined with part of a wire staple. The motor and drive are now ready to be tested. Turn the unit over and apply current. All moving parts should run freely without binding.

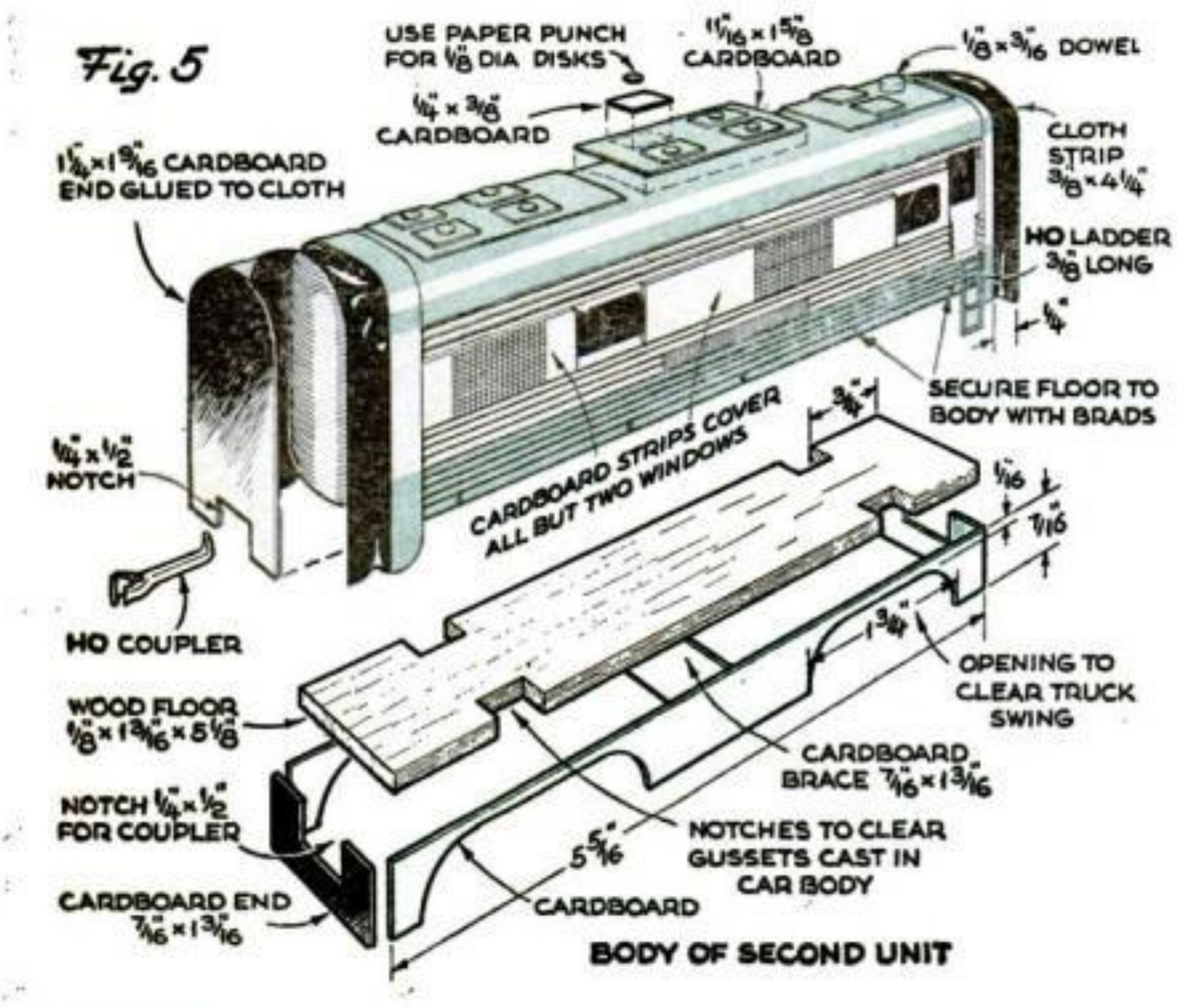
This drive mechanism will operate satisfactorily on circular or oval HO track free of switches and crossings. If the model is to be used in a more complex layout, however, the alternative worm drive shown in the drawing will be needed to clear the rails. Use this instead of bevel gears, fit larger wheels, such as OO gauge, to the HO axles, and employ smaller pulleys. Other details remain the same.

The pickup contacts (Fig. 3) may be mounted on either the forward or rear truck, but should be installed before the trucks are attached to the frame. The contacts must brush the wheels without restricting their movement, and should not touch the metal of the truck. Connect the pickup to the motor with a flexible lead, making it long enough, if the pickup is attached to the forward truck, to allow the truck to swing freely.

Mount the forward truck on a pivot bar so that it can swing as well as turn. Lead weights should be added to the frame to increase traction, bringing the total weight of the locomotive to about ¾ lb.

The final step is the addition of the body (Fig. 4), which is fastened through holes matching those in the frame angle brackets. Remove the toy wheels and axles, and cut off the imitation truck frames, leaving a straight line along the bottom for the cardboard sides.

Construction of the second unit is shown in the drawing (Fig. 5). It has a wood floor and HO trucks, with a block placed between the couplers and the floor to give proper height. Cars are made in the same way.

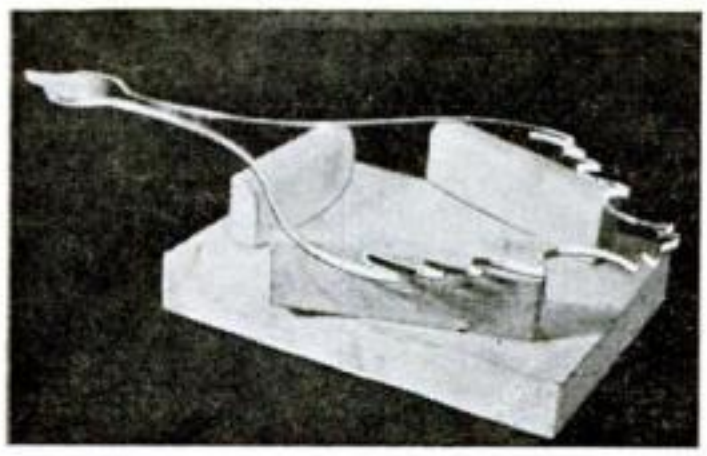


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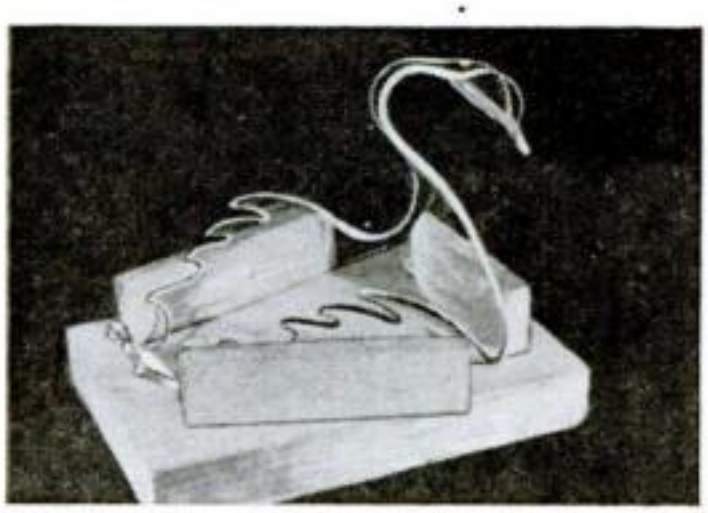
CRAFTWORK for CHRISTMAS



When the pattern is sawed out, and all the edges are filed, sanded, and buffed, lift the protective mask from both faces. Once the paper is removed, the piece must be handled carefully.



Round the corners of the wood, fit the plastic over it, and place both in a warm oven. Insert a dish or sheet of metal under the head to prevent contact with rough surfaces when the neck softens.



If any part is unsatisfactory, you can reheat and reshape the piece. Watch the oven temperature carefully to prevent overheating and blistering. Hold the plastic in position until it is stiff.

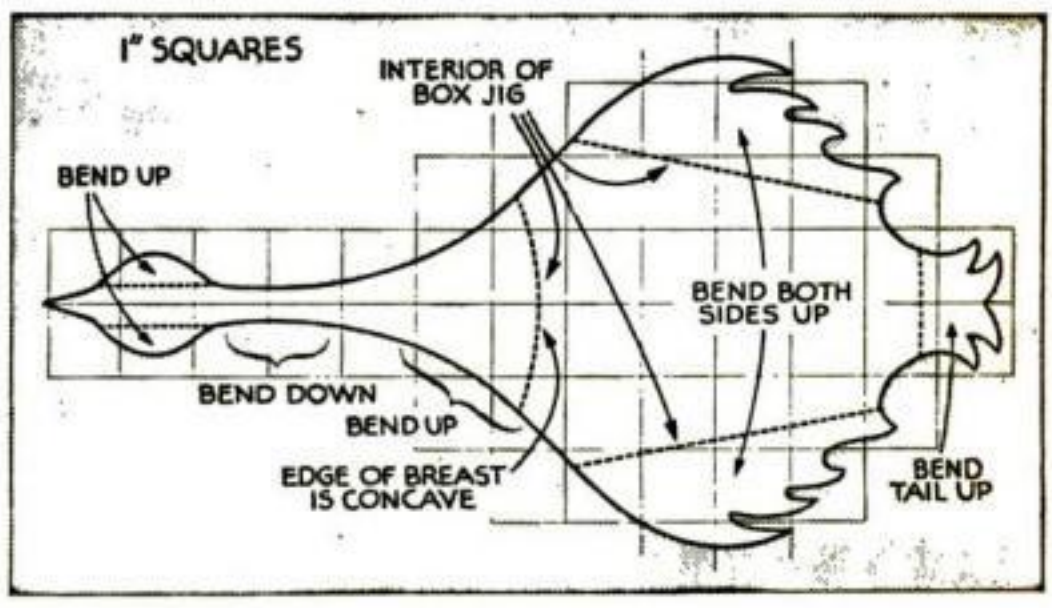


Swan Candy Dish

YOU MAY well wish you were "all thumbs" when you start bending this plastic dish, and discover that a few extra fingers would help immensely. But don't think you've failed if the first tries are unsuccessful: thermoplastic material can be reheated and reshaped as often as necessary.

Draw a grid of squares, and lay out a pattern to any size you like. Paste the pattern on top of the protective paper on the plastic, and saw, smooth, and buff the edges. Nail up a jig to form a shallow box of the shape shown by the dotted lines on the pattern below; balsa is easy to shape and can be sanded to velvet smoothness.

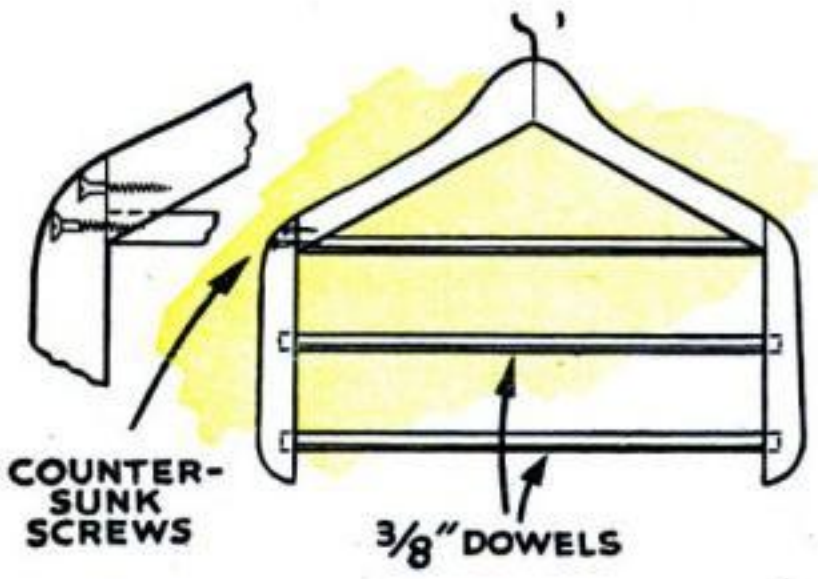
Set the unmasked plastic and the jig into a warm oven until the plastic is perfectly pliable. Then, using clean gloves, force the center portion firmly and squarely down with one hand, letting the wings turn up and supporting the tail with the little finger of the same hand. With the other hand curve the neck and pinch the sides of the head upward. The piece may afterward be colored by immersion in a suitable hot dye.—HARRY WALTON.



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KEEPING the HOME SHIPSHAPE



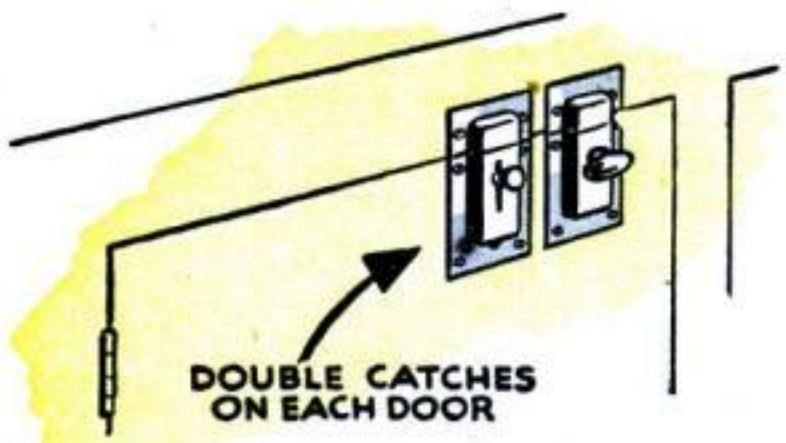


Three-trouser hangers are a boon in closets of limited space. Make the arms of 5/8" stock and glue in the dowels. Cut the ends of a hanger square and screw the extensions in place.

To keep young children out of low cupboards, use two catches—one with a sliding and the other a turning action. While an adult can open the door with one hand, toddlers are kept out.



When your arms are filled with grocery bags or packages, a small shelf on a bracket beside the back door will provide a place for unloading and give you a chance to get at keys and turn the knob. Such a shelf will also hold milk and other deliveries out of the reach of neighborhood cats and dogs.

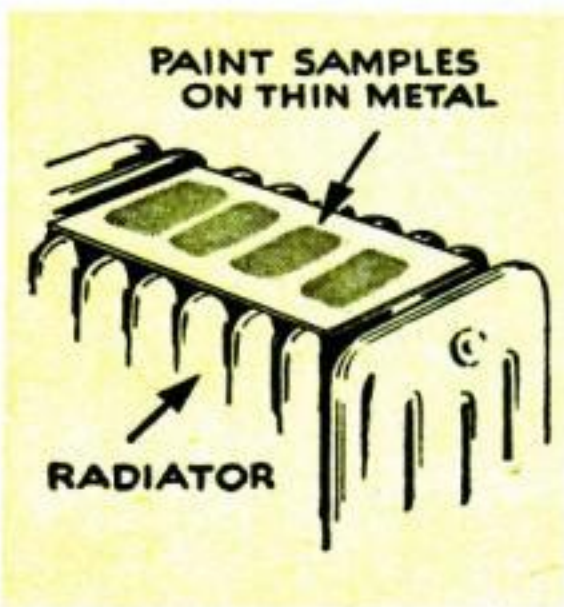


A shower-curtain hook with the small end bent back and inserted behind a cleat in the closet is a convenience for hanging up the vacuum-cleaner extension tube.

One way to make sure newly mixed paint will match when dry is to daub a sample on a piece of tin-can stock and dry it quickly on a radiator or in the oven.

Torn fabric behind the grille of a small radio looks slovenly. Use an old necktie, opened out to one thickness, as a replacement. Hold it with cement and tacks.







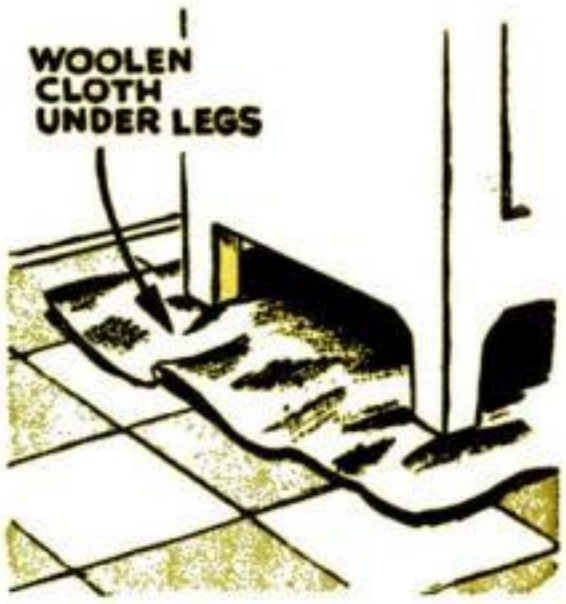
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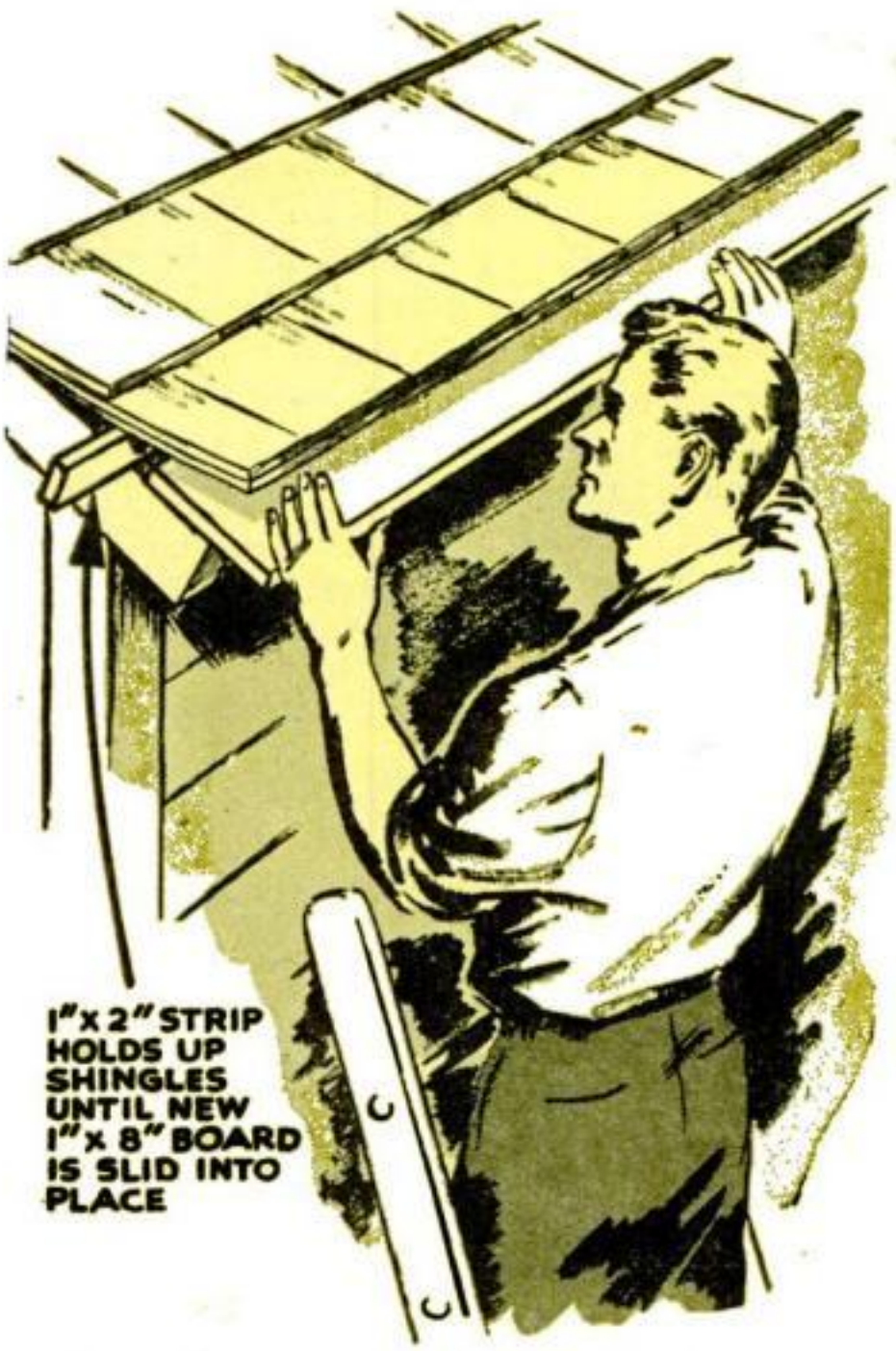
Cracked putty may be softened and reseated simply by running a hot soldering iron over it. Also use the iron to help dig the putty out when a pane is replaced.



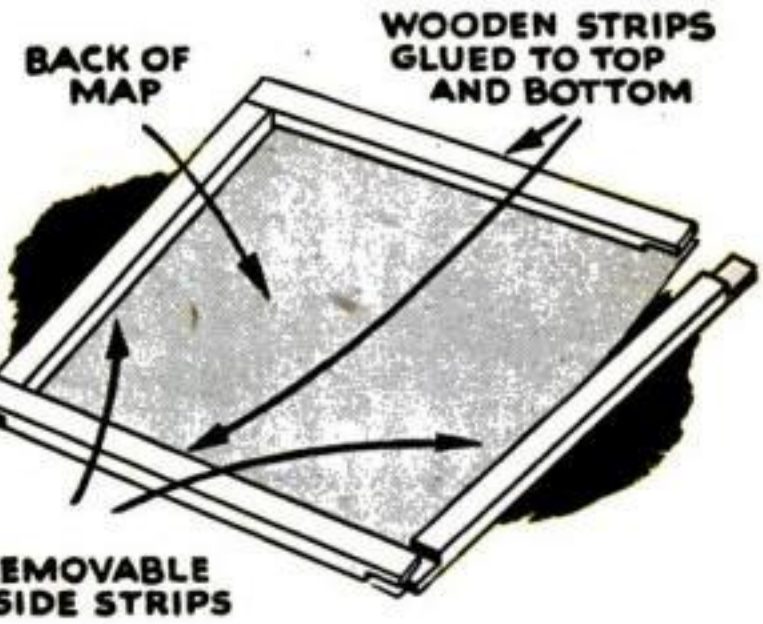
Double glazing can substitute if a storm door can't be used. To install the second pane, saw the old molding lengthwise and put a piece on each side of the glass.



When linoleum is laid, a range, refrigerator, and other pieces can be moved back in place without scarring the floor if an old blanket is used as a skid



To avoid removing shingles when the sheathing under the first course next to the gutter is found to have rotted, slip a 1" by 2" strip under the shingles after drawing the nails. Then turn it on edge, pull the old boards out, slip the new in, remove the strip, and nail.



Maps or charts that are constantly referred tc can be protected with four battens, two of which are permanently attached and rolled up inside. The other two act as spreaders in use.

An old inner tube cut through near the valve, which is then removed, will make a moisture-proof gun case when tied at the ends. Any holes in the tube should, of course, be patched.



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A chalk line helps keep shingles even. Fasten the ends, hold it down at the middle, and snap both sides.

Laying Wood Shingles on a Straight Roof

By EDWIN M. LOVE

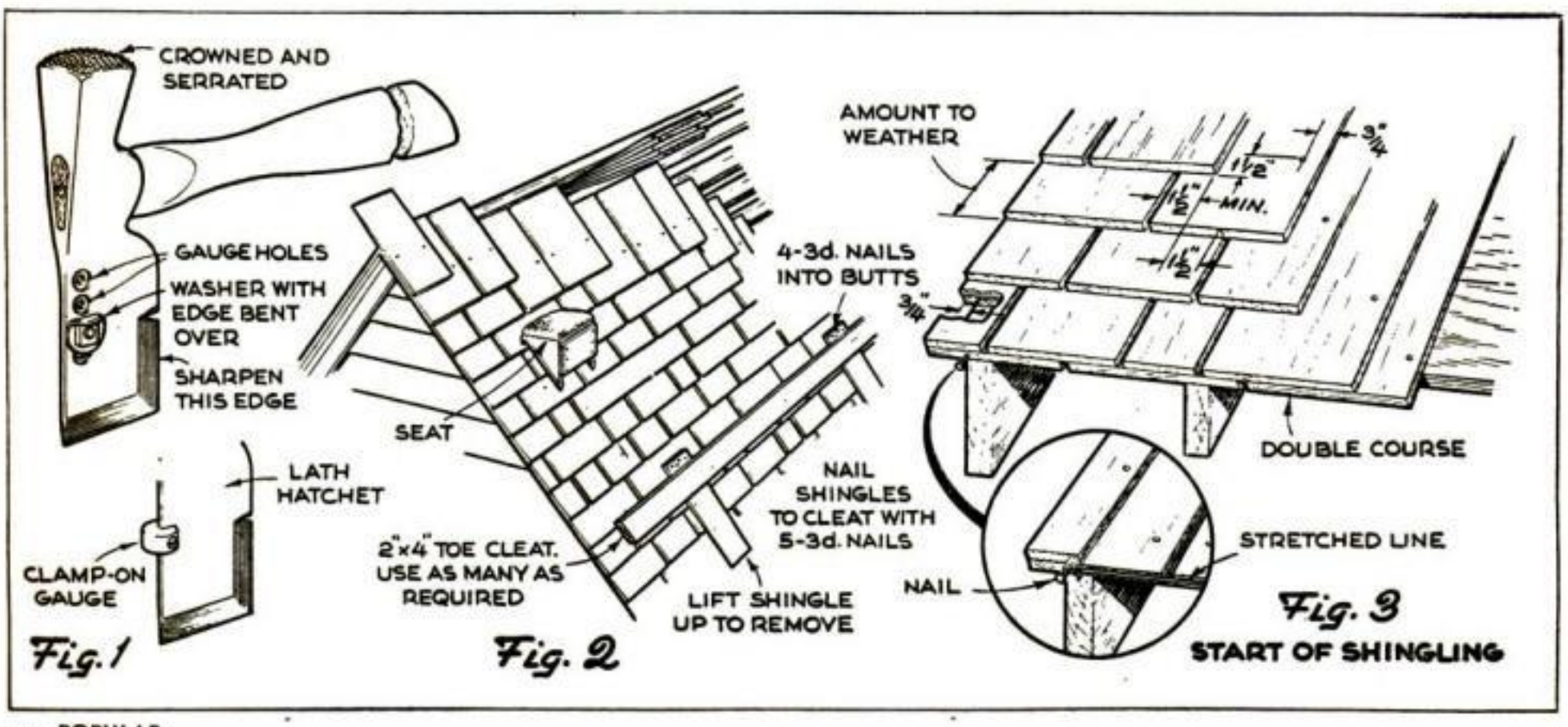
SIXTH OF A SERIES

SINCE you will invest a good deal of labor in shingling a roof, it pays to obtain the best materials. No. 1 cedar shingles are clear and vertical-grained, while No. 2 shingles are slash-grained and occasionally knotty. If second-grade shingles must be used, the life expectancy is reasonably long provided the sheathing has been properly spaced and 3d. galvanized nails are used.

Shingles are usually sold in bundles of 200. Four bundles will cover a "square" (100 sq. ft.) if the shingles are laid 5" to the weather. Five bundles are needed per square if laid 4" to the weather; four and a half will do if the exposure is 4½" and will leave some extra for rip-rap.

Do not waste time with a hammer or ordinary hatchet, but obtain one like that in Fig. 1 and make a keen edge on the back of the blade. A nail sack with an oversize pocket, such as a large, heavy patch stitched on a shop apron, is also a necessity.

Build a simple seat, or "jack," to fit the pitch of the roof, as shown in Fig. 2. Make the sides of 1" stock and cut the bottom to



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the roof slope. Use double thicknesses of shingle butts or plywood for the seat and back. Two strips of ⅛" by ⅝" iron drilled and screwed to the inclined edges will serve as spurs. Bend the ends and file them to chisel edges so they will grip. On a steep roof, use toe cleats as well (Fig. 2).

Carry up several bundles and distribute the shingles by sticking handfuls between the sheathing about 3′ above the eaves. Work can be started with the shingler on the roof if it is no more than quarter pitch.

Nail the first shingles at the corners, as indicated in Fig. 3, gauging the butt projection beyond the sheathing with the hatchet head against the edge and the handle against the shingle. Professionals gauge this ¾" projection beyond the shingle mold with the eye, but a strip may be tacked to the mold as a guide. Stretch the starting line and nail shingles at intervals to keep it from sagging. Then lay a double course, driving the nails near the butts in the first layer and inclining them to avoid pricking through the overhang. If the shingles are dry, space them about ¼" to allow for swelling.

Sometimes a chalk line is struck over the double course to guide the next one; and it's a good plan to use a line when courses become noticeably irregular. On a long roof, fasten the line at both ends, press it down at the center, and snap the halves.

Because of a mistaken notion that a gauge is hard to manage, most amateurs prefer a straightedge. If you insist on using one, it should be narrower than the shingle exposure, as in Fig. 4, to prevent hiding the joints. Tack it with shingle nails and pry



Start shingling at one corner, gauging the first shingle to project ¾" beyond the shingle mold, and drive a nail in the butt for a starting line.

with the hatchet blade for moving. Instead of nailing the shingles individually, lay out a row the length of the straightedge at a time.

An inexperienced man may lay only six bundles in a day, while a professional often lays 30 or more. The difference is largely due to the use of a hatchet gauge and carrying nails in the mouth. A shingler tosses a small handful of nails into his mouth, works out two points with his tongue, and picks them out between thumb and forefinger. This trick can hardly be mastered in one job, but it is quicker than taking from a pocket.

Galvanized nails may make your lips very sore after a couple of days, but if you perse-

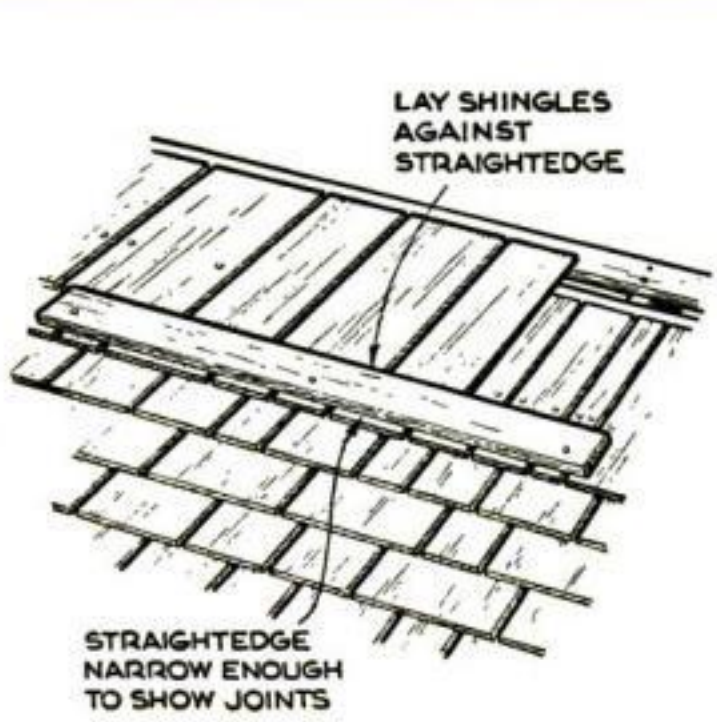


Fig. 4

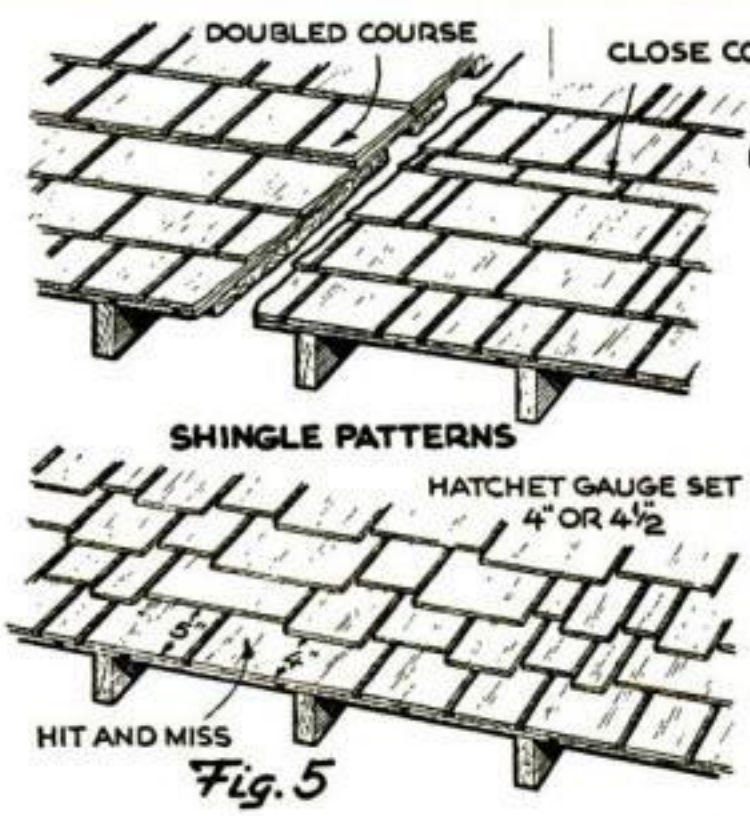


Fig. 5



Fig. 6



Fig. 7

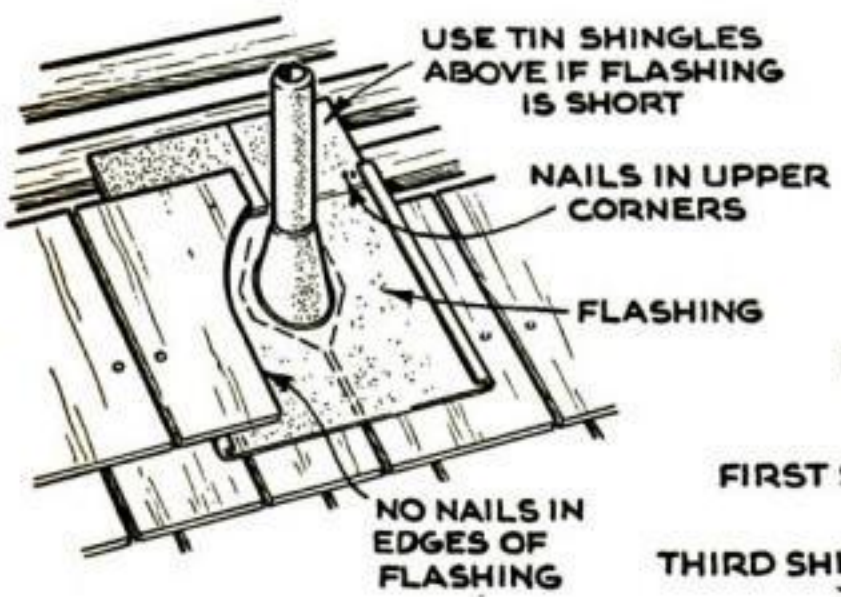
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vere for a few more days your lips will become hardened. However, a stripper may be made from sheet iron, as shown on page 174, hung above the nail pocket, and used instead of the mouth.

Gauge a shingle with the hatchet, as shown in the photograph at right. The left hand, with a pair of nails in the fingers, holds the shingle in place while the hatchet is raised for a blow. Strike a nail to start it and again to sink it, drawing back the hand between blows. Without breaking rhythm, place the other nail and drive it. An hour can be



Gauge placement of the shingles with the hatchet, catching the gauge on one shingle and butting the new one against the head. The left hand holds two nails, one in readiness for driving.



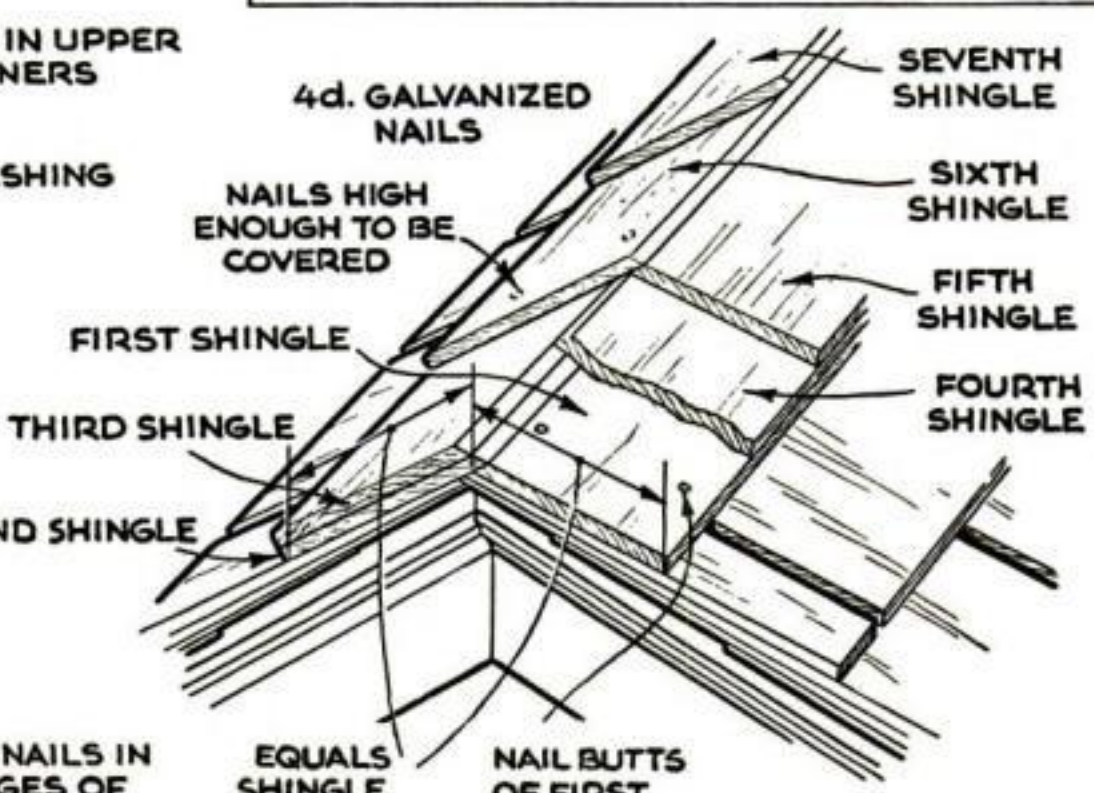
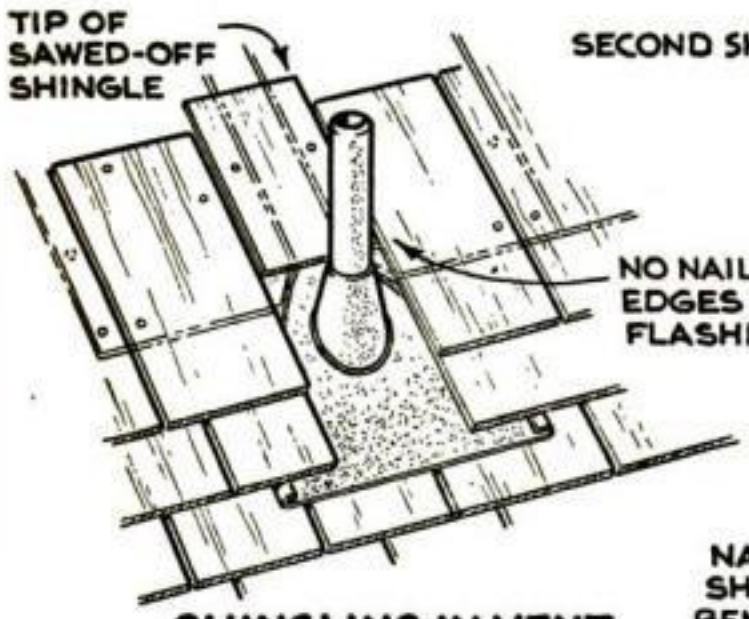


Fig. 10

PUTTING ON RIP-RAP



SHINGLING IN VENT

Fig. 8



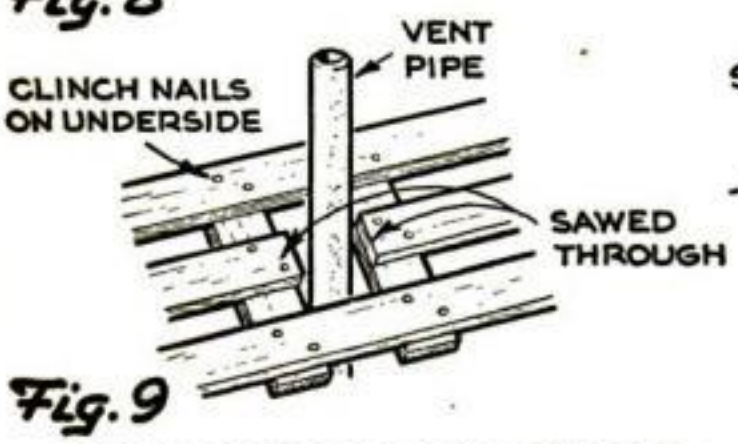


Fig. 9

SUPPORT FOR CUT BOARDS

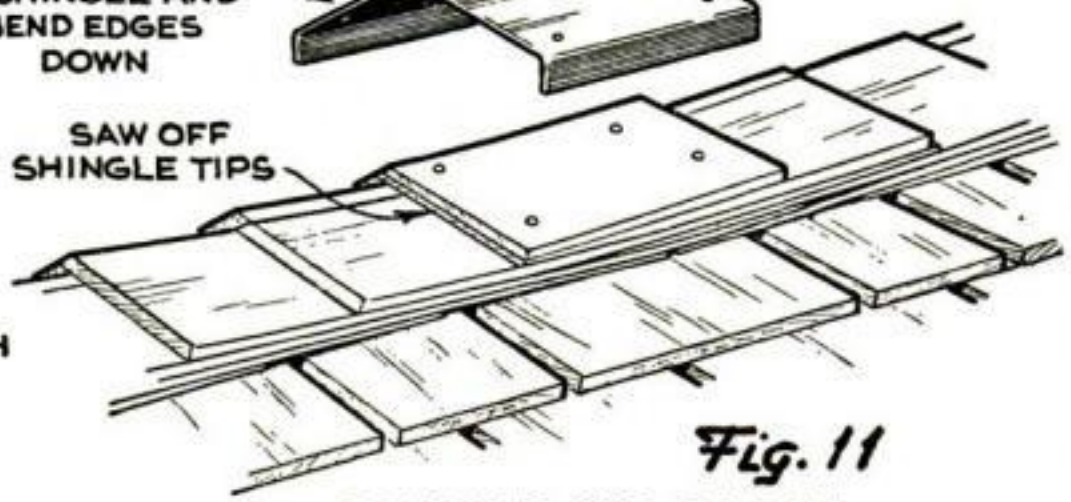


Fig. 11

CAPPING RIP-RAP AT CENTER OF RIDGE

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Cut the top shingles flush with the ridge, using the sharp corner of the hatchet and pressing against the elbow with the knee. Hold down the butt with one foot when breaking off the tips. At right, putting on rip-rap. Some shinglers prefer to sit astride the ridge after the work has been well started.

wasted in a day if you lose a count in shifting to the second nail. If six courses are carried at once, and the shingles are of good width, it is usually possible to find a place to use every shingle picked up.

Shingles are laid in a variety of patterns, some of which are shown in Fig. 5. Irregular "hit-and-miss" courses break up severe regularity, while regularly recurring double or close courses relieve monotony and emphasize the length of the building.

Avoid aligning joints in alternate courses. Shingles that crack when being nailed almost invariably do so over a joint in the course below, and if there is also a joint directly above, this puts three in alignment and results in a possible leak (Fig. 6).

If shingles run narrow, the side lap may have to be decreased at least for alternate courses. Save out some 4½″ to 5″ wide for the rip-rap. Watch for cross-grained shingles and flip them over to point the grain downward, as in Fig. 7. Place knots over solid sheathing and bridge them with sound shingles. Save some for ridge courses where knotty ends are cut off.

Vent flashings must be shingled in, and most are handled as in Fig. 8. As lead flashings (not shown) have wide aprons, nails must be driven through the shingles into them. Keep shingles from 1″ to 2″ from the pipe sheath, depending on size, and leave troughs for dirt and leaves to wash out. Some building ordinances require all wood be kept 6″ from metal or composition flues.

When vent pipes cannot be brought up between sheathing boards, one must be cut through. Stiffen the ends by nailing cleats beneath at each side, as shown in Fig. 9.

The ridge course should show a normal exposure below rip-rap—never more and little less. When shingling nears the ridge, measure the distance and reset the gauge to make the last course right. Cut projecting shingle ends with the hatchet corner and stand on the butts when breaking the tips.

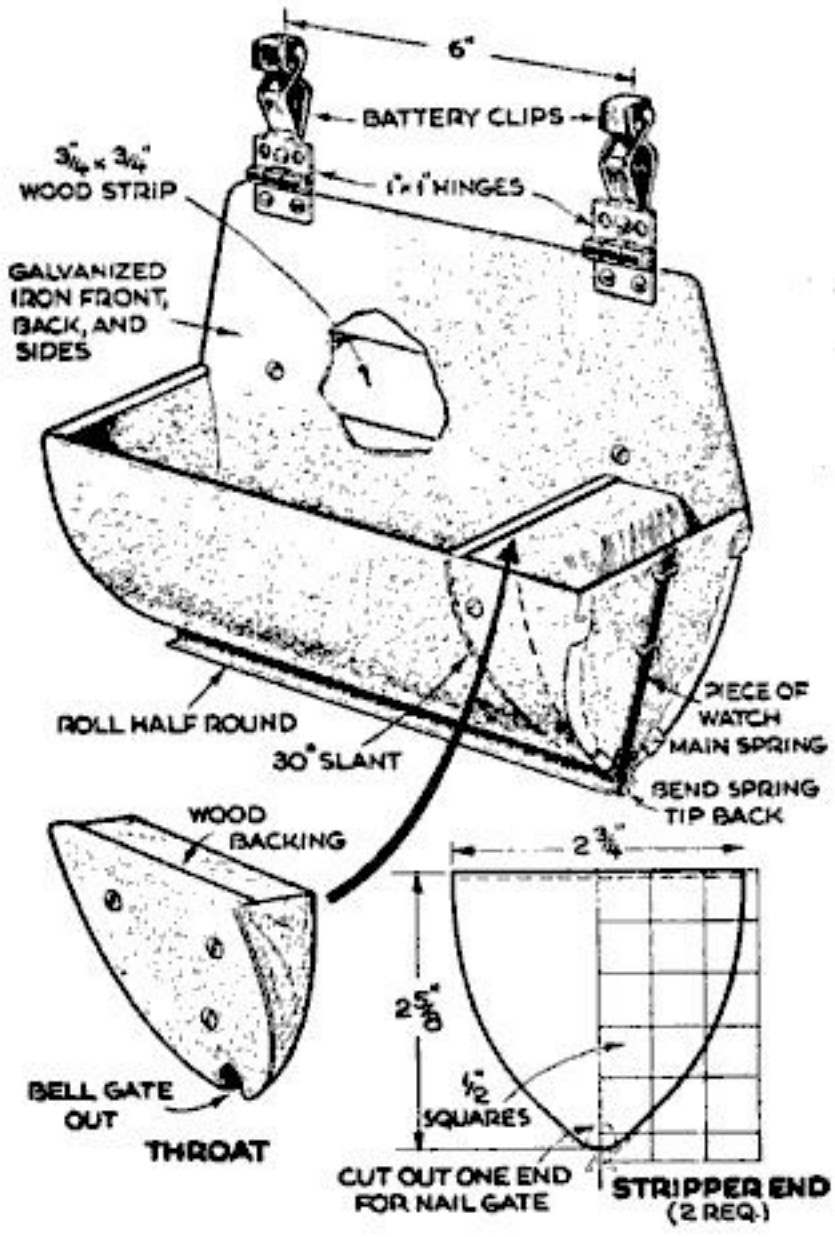
When saving out shingles for rip-rap, estimate the number by these formulas, in which L stands for ridge length in feet: 4″ to weather, 6L plus 4; 4½″ to weather, 16L divided by 3, plus 4; 5″, 5L plus 4.

Strike chalk lines for each side of the ridge, mark the center, and work toward it from the ends. Start by nailing a shingle and trim the upper edge flush with the opposite slope. Lay the second shingle on this slope, lapping over the first, and trim flush with the first. The third is over the second and the fourth over the first (Fig. 10). Succeeding courses are single.

Trim the center or cap shingles to show the same margin at both ends on shingles below, and finish with a tin shingle, as in Fig. 11, to keep the caps from splitting off.

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Nail Stripper Saves Sore Lips



A STRIPPER, or nail dispenser, will prevent lip sores from galvanized nails when you shingle your house. Properly made, it is nearly as efficient as holding the nails in the mouth. Nails hang by the head point down in the slot, ready for picking. The *V* prevents crosswise jamming, and the inclined throat eliminates catching of heads as nails are drawn through the gate. If the stripper is jarred often to shake up the nails, few will drop head first into the gate.

Cut the parts from heavy galvanized sheet iron and roll the slot edges over a 3/8" rod. Bend the tabs, tack-solder the ends, adjust the slot width, and finish soldering.

The success of the stripper depends largely on the throat. Trim the wood backing until its gate will lie close to that in the end. Cover the face with sheet metal and bell it into the gate, fairing it smoothly. Fill any space in the fit with composition wood.

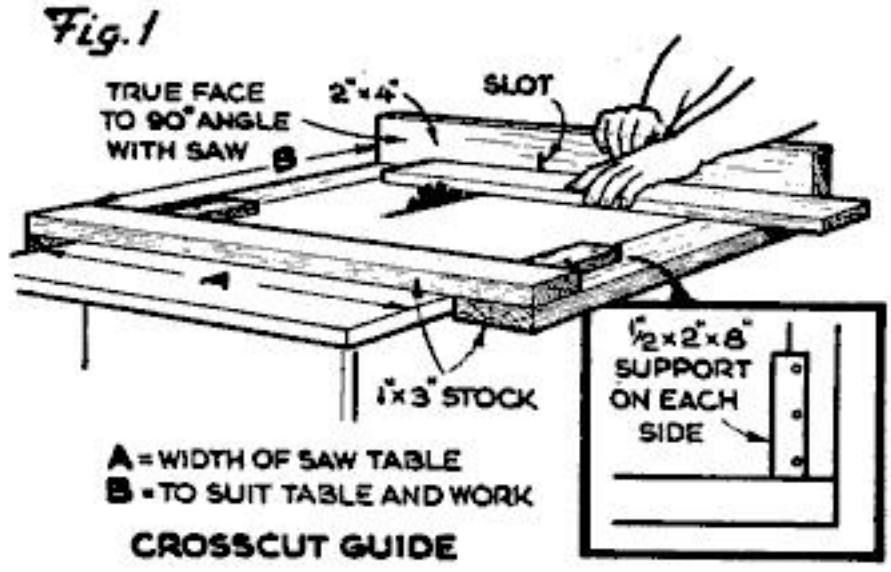
Suspend the stripper with small battery clips and riveted hinges so it will swing. After satisfactory tests, install the spring and lubricate the inside.—E. M. L.

Crosscutting and Ripping Guides Square Work on Saw Table

BEFORE starting the crosscut guide shown in Fig. 1, square the two side edges of the table parallel with the cutting plane; then mark a line on the table at right angles to and about 10" in front of the saw. Nail the back-support strips to the sidepieces and tack the backpiece lightly. Try on the table and adjust to bring the sidepieces in full-length contact. Lay the frontpiece on the table with the guide face parallel to the marked line, tack to the sidepieces, readjust as necessary, and nail the four joints firmly. Finally, cut the saw slots with the table-saw blade.

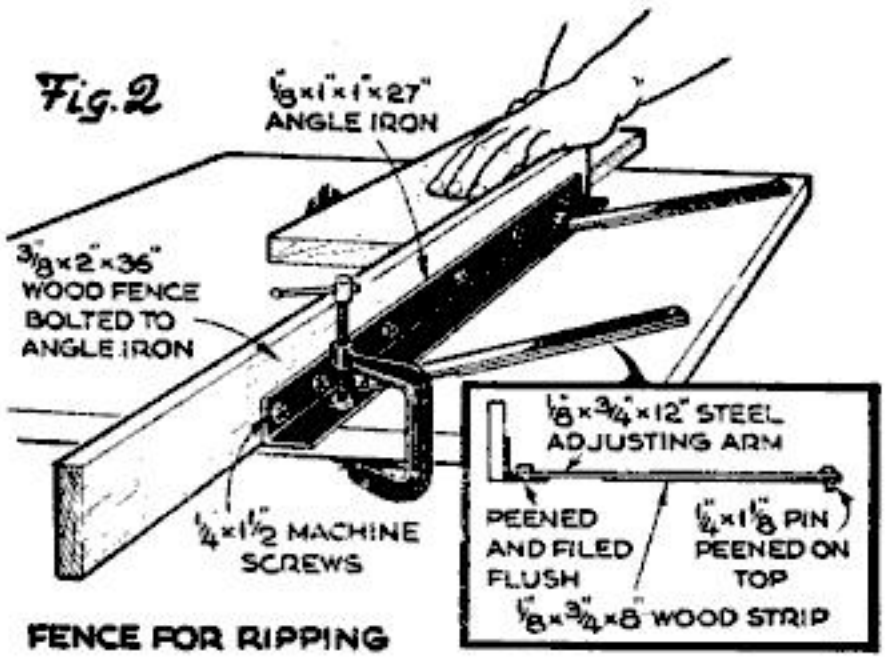
The ripping guide in Fig. 2 was designed for a table 36" long. In laying out the two guide holes to be drilled in the table top for the locating pins, make certain they are parallel to the cutting plane and equidistant from the saw centerline. The distance between centers of the holes must be the same as that between the connecting pins in the angle iron. To assure this, clamp the angle to the table and drill through its holes. The length of the arms should suit the table. If it is very wide, drill several sets of guide holes.—EDWARD R. LUCAS.

Fig. 1



CROSSCUT GUIDE

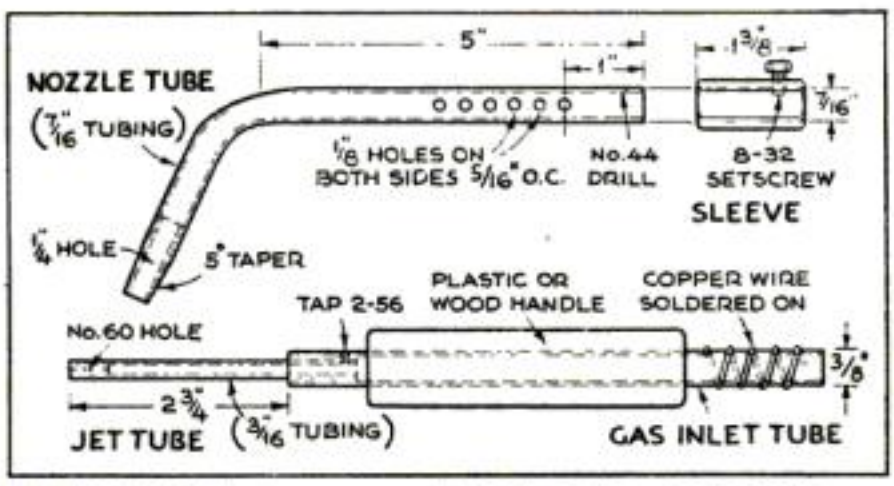
Fig. 2



FENCE FOR RIPPING

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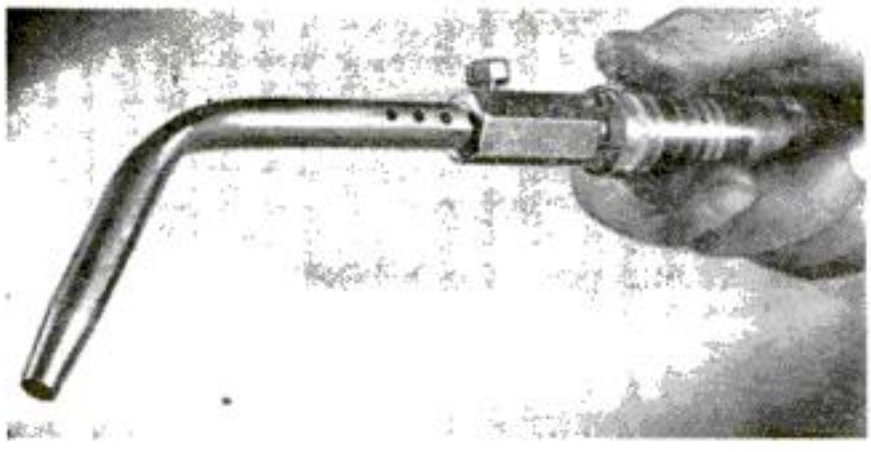


Gas Torch from Brass Tubing

AN EFFICIENT gas torch for workshop use can be built from standard brass tubing. The gas inlet tube is a 6" length of 3/8" o.d. tubing with a plug 3/4" long soldered in one end. Drill a 3/16" hole in this plug and solder in 3½" of 3/16" tubing, which should project about 2¾". Fit the end with another plug ½" long drilled through with a No. 60 drill.

The nozzle tube is made from 8" of 7/16" o.d. tubing of an inner diameter to slide closely over the gas inlet tube. A 1" plug with a 1/4" hole is fitted in one end. Bend the tube about 5" from the other end after heating it red hot. When cool, drill six 1/8" holes straight through, the first 1" from the inlet end and the others 5/16" apart. A 1 3/8" long regulating sleeve, which slides over the holes to control the air supply, is made from round or hexagonal stock drilled with a 7/16" hole and locked with an 8-32 setscrew.

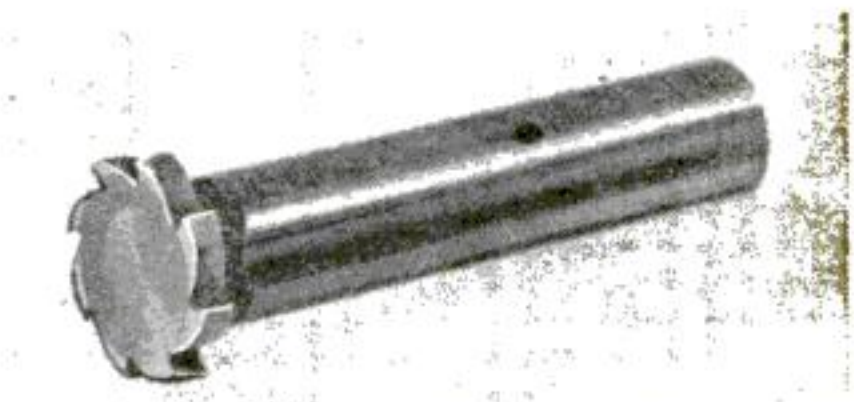
The handle, a 4" piece of 7/8" plastic or wood rod with a 3/8" hole straight through, is slipped over the inlet tube, leaving about 1¾" projecting for the hose connection. Assemble with the sleeve in place, sliding the nozzle over the inlet tube and against the handle. Finally, drill and tap for a 2-56 screw to hold the nozzle tube. Adjust the air sleeve until the flame becomes a clear blue.—HERBERT PFISTER.

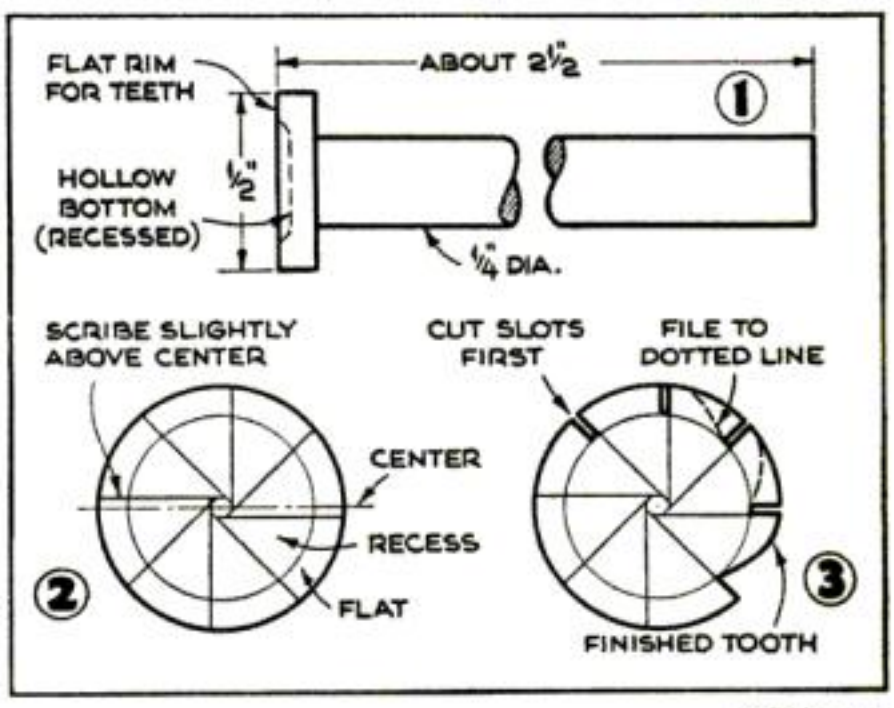


Grooving Cutter of Drill Rod

A DUAL-PURPOSE rotary cutter that makes grooves of any width and also serves as a planer on wood or soft metal can easily be machined from ½" drill rod. Turn the blank as shown in Fig. 1, making a somewhat concave face to eliminate drag when the tool is employed for planing. Next, scribe eight marks from slightly above center straight out to the left (Fig. 2), using the index head of the lathe for spacing. If no surface gauge is available, use a sharp-pointed tool turned on its side and advanced by the cross feed to mark these lines.

Cut slots to the left of each mark with a jeweler's saw or knife file and form the teeth to the shape shown in Fig. 3. Harden the cutter by heating it to a cherry red and plunging into oil. Sharpen the teeth with a fine stone.—H. P.





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CEMENT with an Iron Heart



Iron cement usually comes as a dry gray powder, and all you need to do is mix it with water in a container, as above. For certain jobs it should be mixed to a stiff putty, for others a thin paste.



If a wood screw becomes loose in its hole, iron cement is a good solution to the problem. Simply apply a small amount of cement, as above, insert the screw, and the cement will anchor it tightly.

Furnace cracked? Or plumbing leaky? When such things occur, reach for the tough customer of the fix-it compounds.

By WALTER E. BURTON

ANY list of materials for use in the home and shop should include iron cement well up near the top. With an all-purpose iron cement, you are ready to tackle many a repair job that would otherwise be difficult or impossible. And if the task calls for something specialized, there's a good chance that an iron cement is made just for that job.

For the most part, iron cements consist of a large proportion of powdered iron, plus a few other ingredients that vary according to the brand and intended use. A typical cement, for instance, might include 60 parts of powdered iron, 2 of sal ammoniac, and 1 of flowers of sulphur.

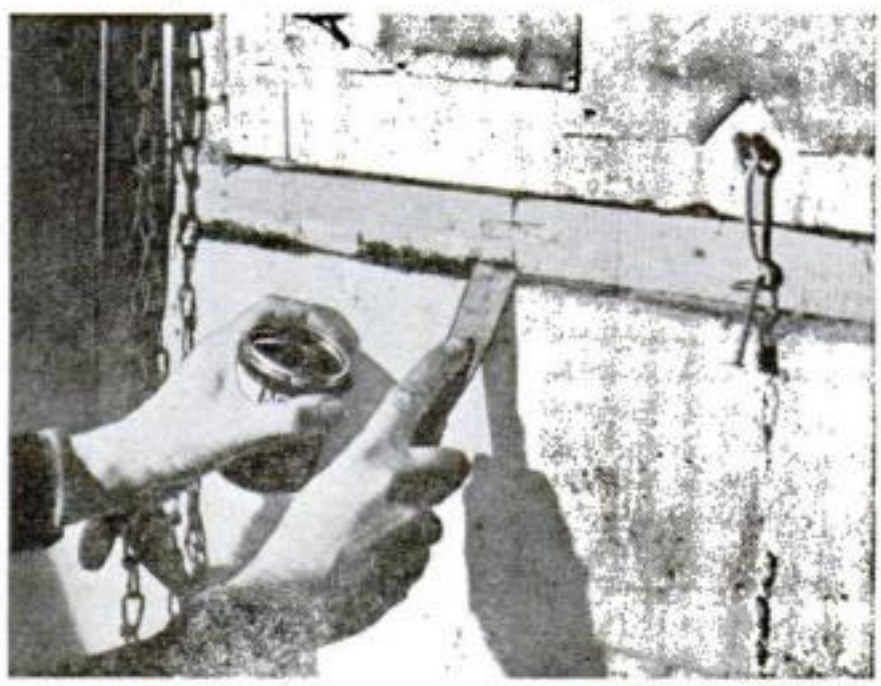
When hardened in a mass, some of the commercial iron cements are fairly brittle and may fracture if struck a sharp blow, but when confined by solid iron or steel, as in a crack or hole, they seem to resist breaking quite well. They can be drilled with high-speed twist drills if the feed is kept gentle to prevent cracking, and they can be sawed and filed, although the going may be somewhat tough. Like solid iron, iron cement may rust if left unprotected.

You can buy iron cement in cans contain-

A hole in a metal cylinder can be repaired with a self-tapping screw and a plain washer. Apply a little cement to the washer and screw down tight.



Cracks that allow winter winds to enter around a cellar window can be calked with an iron cement mixed to putty consistency and applied as below.

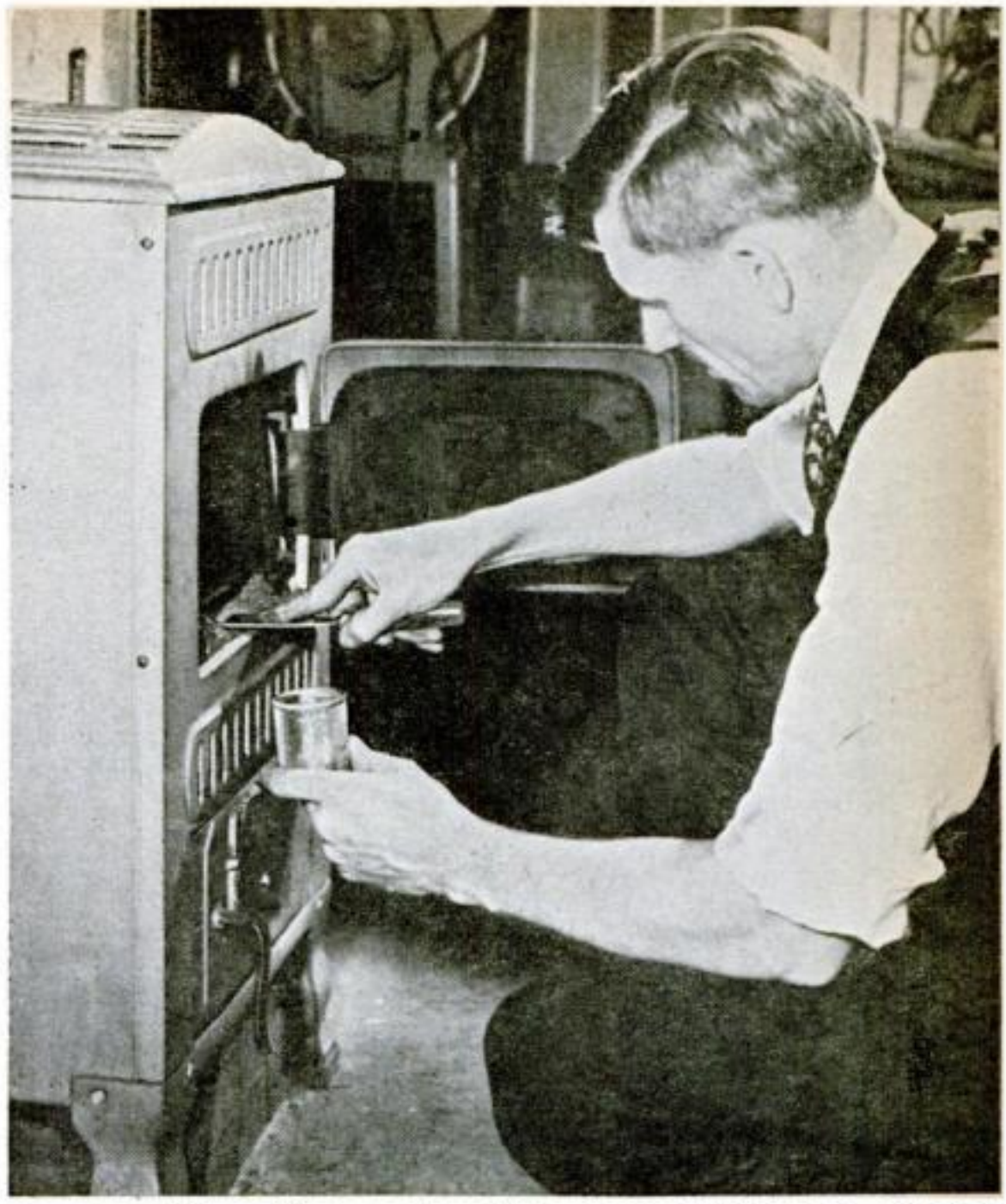


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ing only a few ounces or in kegs containing up to 100 lb. A few specialized preparations are sold in paste form, but the typical all-purpose iron cement is a dry, gray powder that is easily mixed with water to form a putty-like paste. This sets rapidly to iron hardness. In that state it is resistant to flame, water, oil, gasoline, steam, and various chemicals.

A paper cup is handy for mixing small amounts of the powder form, since it can be discarded after use, but other containers will do if you wash out the excess cement before it hardens. For mixing and applying small quantities, a wooden paddle serves well, though it is better to use a putty knife or trowel for the larger jobs.

Water and powder may be proportioned to produce either a stiff putty or thin paste, the particular application determining the best consistency. The stiffer mixes will dry in less time and develop greater ultimate hardness. When extreme hardness and compactness are required, the cement often can be tamped or hammered into place.



Iron cement is an ideal compound for many repair jobs on a heater.

Types of iron cements other than those intended for all-around use include the following specialized mixtures:

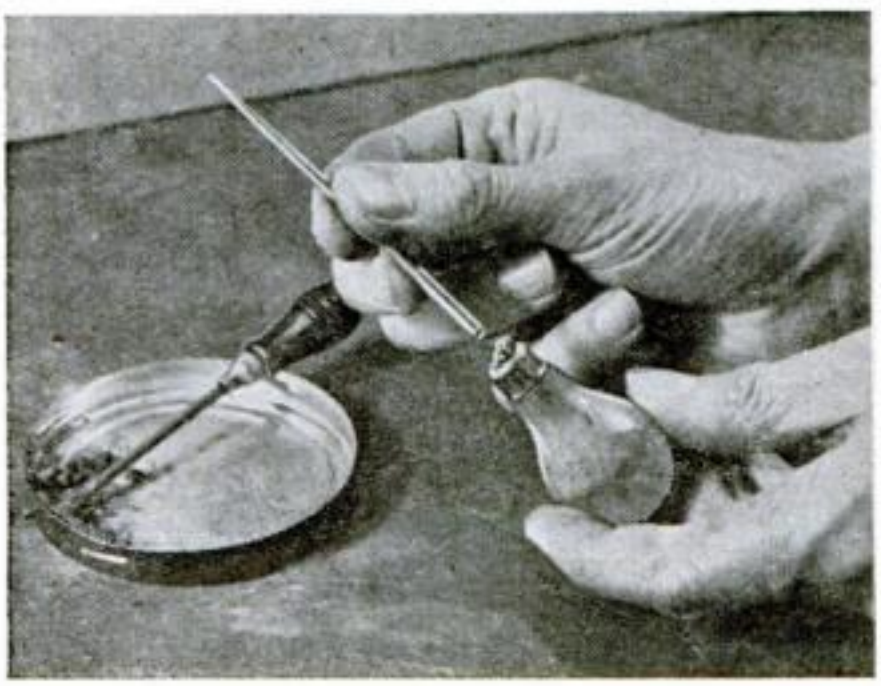
A foundry cement for filling blow holes, cracks, and other irregularities in cast iron, and for covering recessed heads of bolts and screws.

Hydraulic iron cement that hardens slowly under water. In other respects it is similar to faster-hardening all-purpose cements.

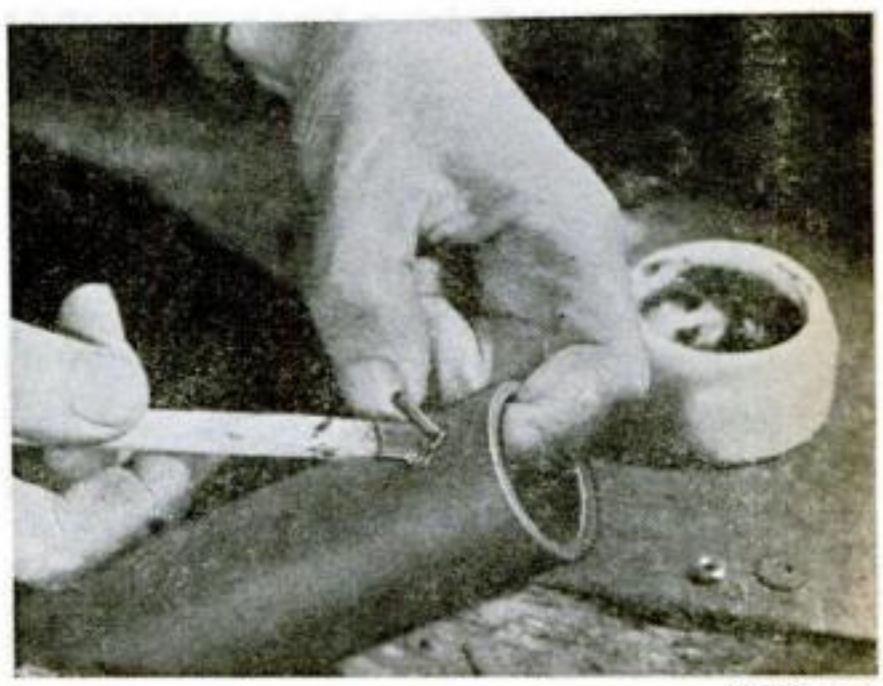
Plastic iron putty, suitable for filling holes and seams in metal and wood and making water-tight joints between glass and metal.

A soft-metal mixture intended for use in

Loose handles on your shop tools, furniture, and kitchen equipment may be reset with iron cement. Wipe away any excess cement before it hardens.



Iron cement effectively plugs holes in pipes and boilers. Sandwich it between plain washers drawn against each side of the hole with a bolt and nut.

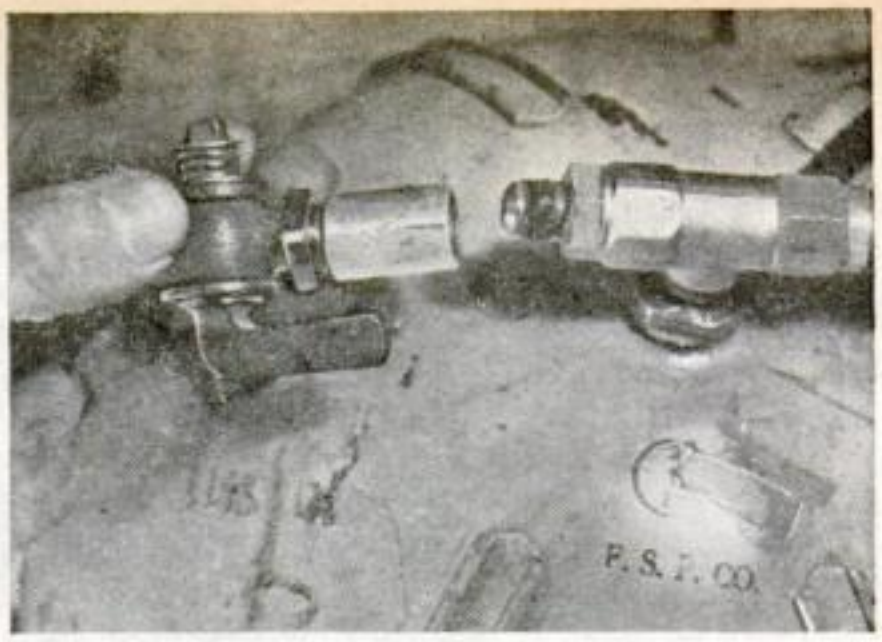


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For greater efficiency, you should seal the crack around the top door of a gas-burning furnace. The job can be done with iron cement, as shown above.

How a stud may be anchored in a concrete wall is seen below. The stud is a bolt, its head inserted in a hole which is then packed with iron cement.



Applied to pipe threads, iron cement makes joints leakproof. A special preparation for this purpose permits loosening of such joints at a later time.

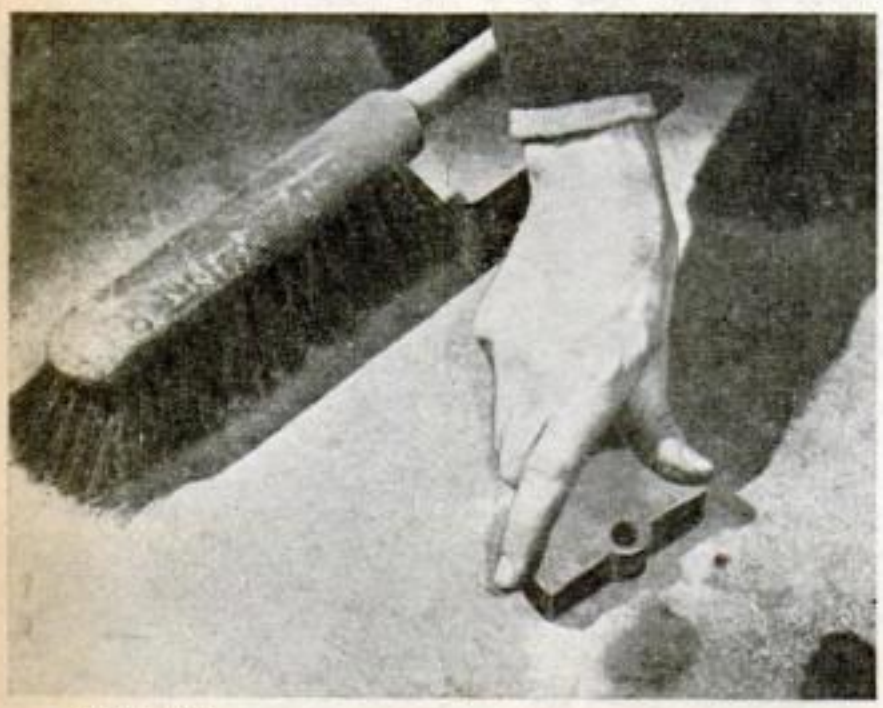
Oversize caster holes in furniture may be built up with iron cement mixed to the consistency of fairly stiff putty. Wipe away the excess cement.



Special iron cements are available for repairing cracks in a concrete floor, but a general purpose cement will do. Below, a broken abrasive wheel is used to smooth the surface after one such job.

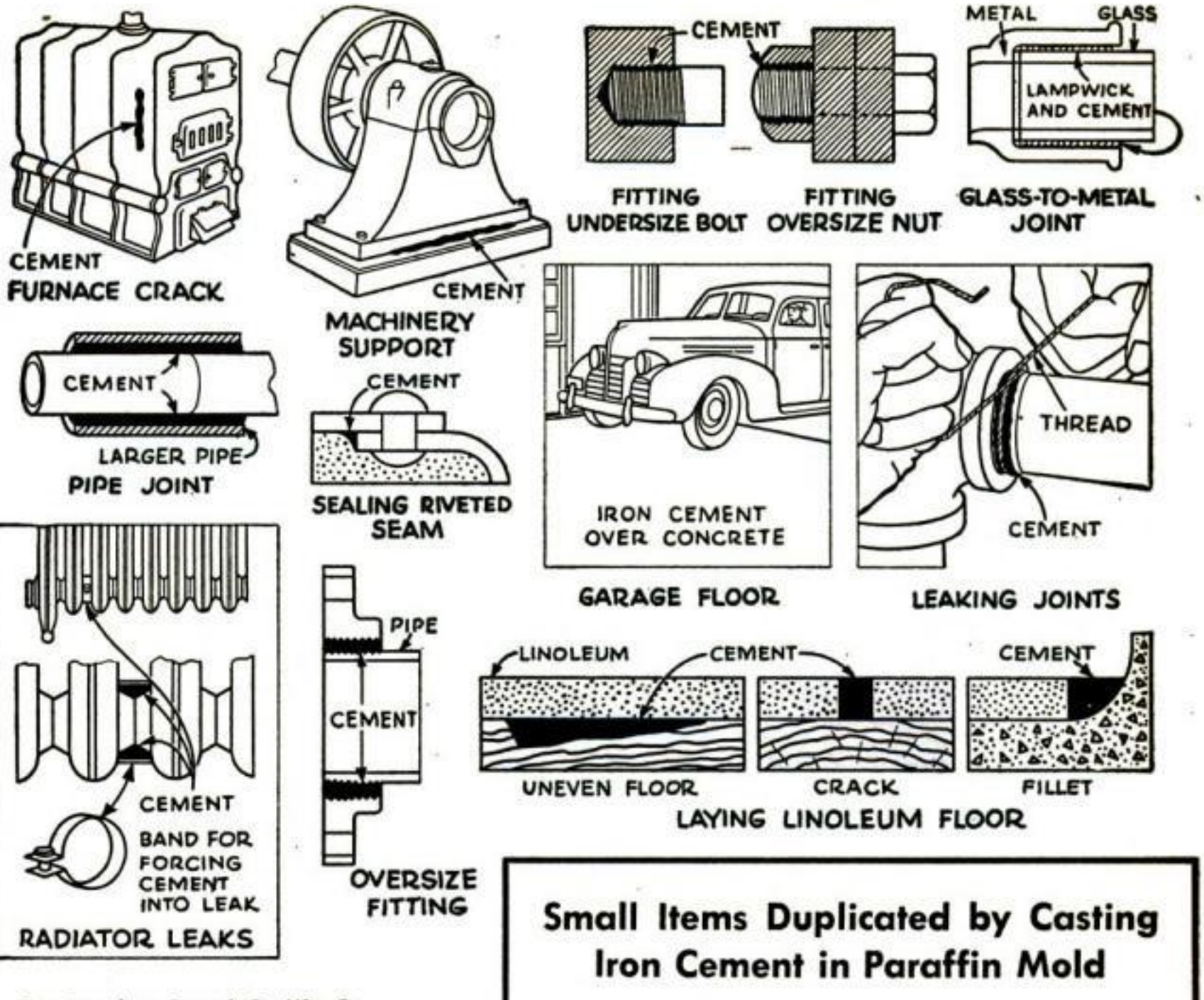


Below, recessed boltheads in a steel assembly are covered with iron cement. Special types matching the color of cast iron are available for filling blow holes and other irregularities in castings.





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Drawings from Smooth-On Mfg. Co.

thin applications on pipe threads and other joints. Since this withstands high heat and pressure, it is useful for sealing seams in boilers. When threaded joints are sealed with this cement, they may be taken apart later if this is necessary. General-purpose iron cements are frequently used for permanent sealing of pipe joints.

Special cements for calking joints in cast-iron soil pipes, gas lines, and similar jobs are also obtainable. Others are intended for waterproofing and hardening concrete floors and walls, for repointing old masonry, and for patching holes and cracks in concrete floors that bear heavy traffic.

Aside from the true iron cements there are also special preparations for such jobs as patching surface holes and irregularities and filling cracks and joints in aluminum and bronze.

The accompanying photographs and drawings show only a few of the virtually endless ways in which iron cement may be used.

Small Items Duplicated by Casting Iron Cement in Paraffin Mold

AMONG the more unusual applications of iron cement is the duplicating of molded shapes, such as the upholstery tacks in the photo below. Here a mold was made by pressing the head of one of the original tacks into warm paraffin. The depression then was filled with iron cement mixed to moderate stiffness, and a carpet tack was embedded in the mixture. When the cement had set, ragged edges were filed smooth and the cast was painted to match the tacks.

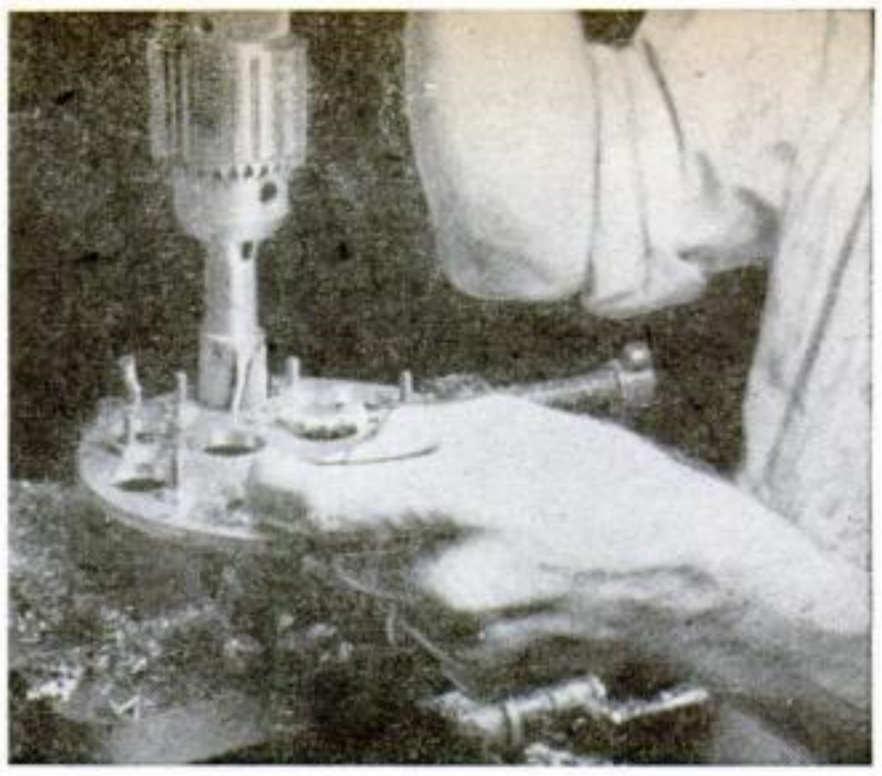


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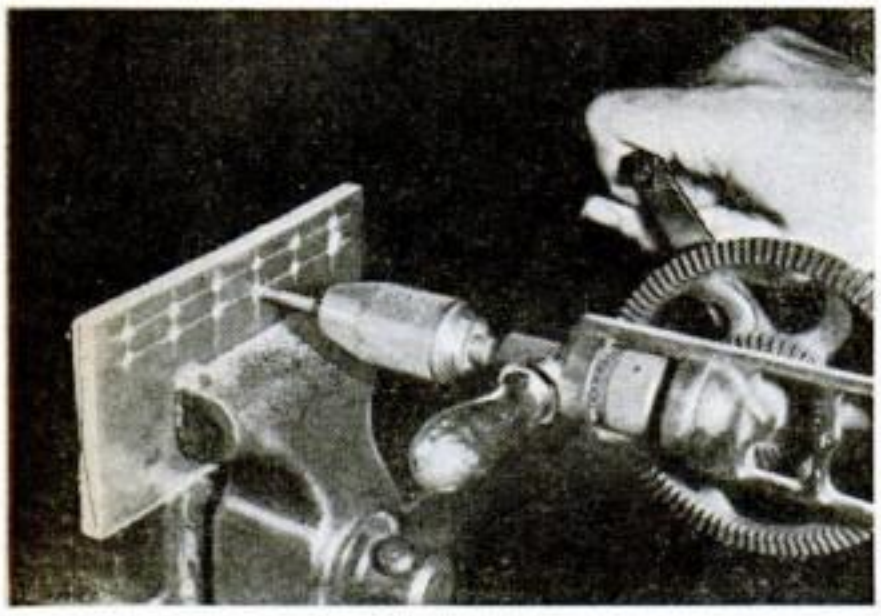
NEW SHOP IDEAS



LARGE COUNTERBORES, too big to fit in a ½" drill-press chuck in the regular way, may still be used if they are the type that has a removable pilot in a longitudinal through hole. Take out the pilot and replace it with a length of cold-rolled steel that will extend beyond both ends of the counterbore. The upper part can then be chucked, while the other end serves as the pilot.

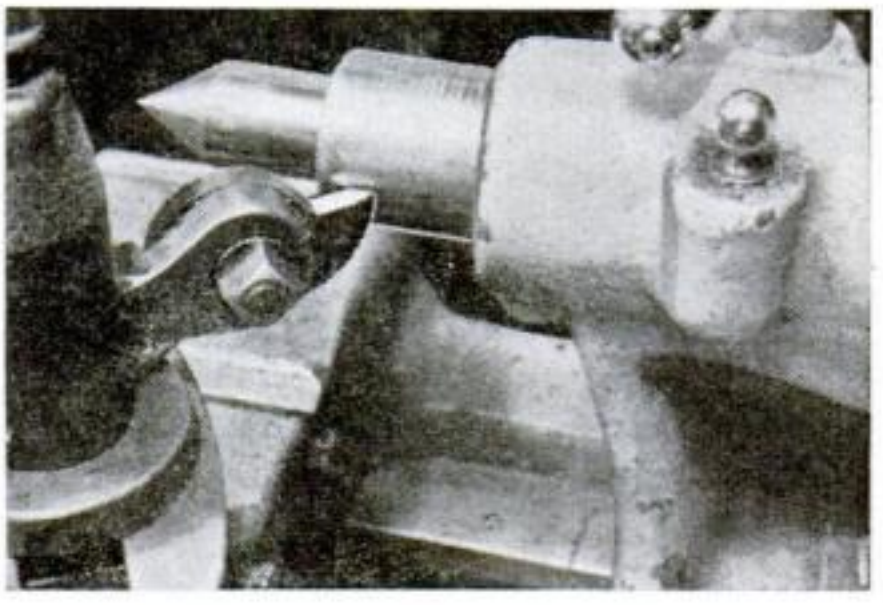


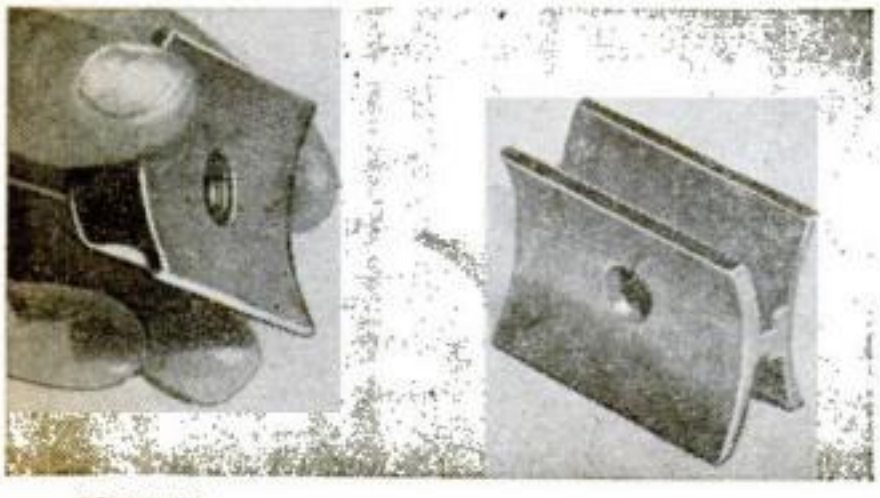
The photograph at left above shows a counterbore equipped with an extra-long pilot, and at right it is seen in use opening out holes in a plate.—J. C. MAGEE.



TAPPING A NUMBER OF HOLES in soft material such as plastic is accomplished quickly and easily by using a breast drill. While not a precision method, it will produce acceptable work if the drill is held without wobbling.—J. C. M.

SETTING A THREADING TOOL is possible without a center gauge, for the tailstock serves to line up the tool with reasonable precision. With the tool held loosely in the post and the compound rest at 60 deg., move the slide until one side of the 60-deg. tool touches the tailstock barrel. Tighten the post, holding one cutting edge of the tool firmly against the barrel. Then back the tool away and reset the compound rest to zero.—WILL THOMAS.

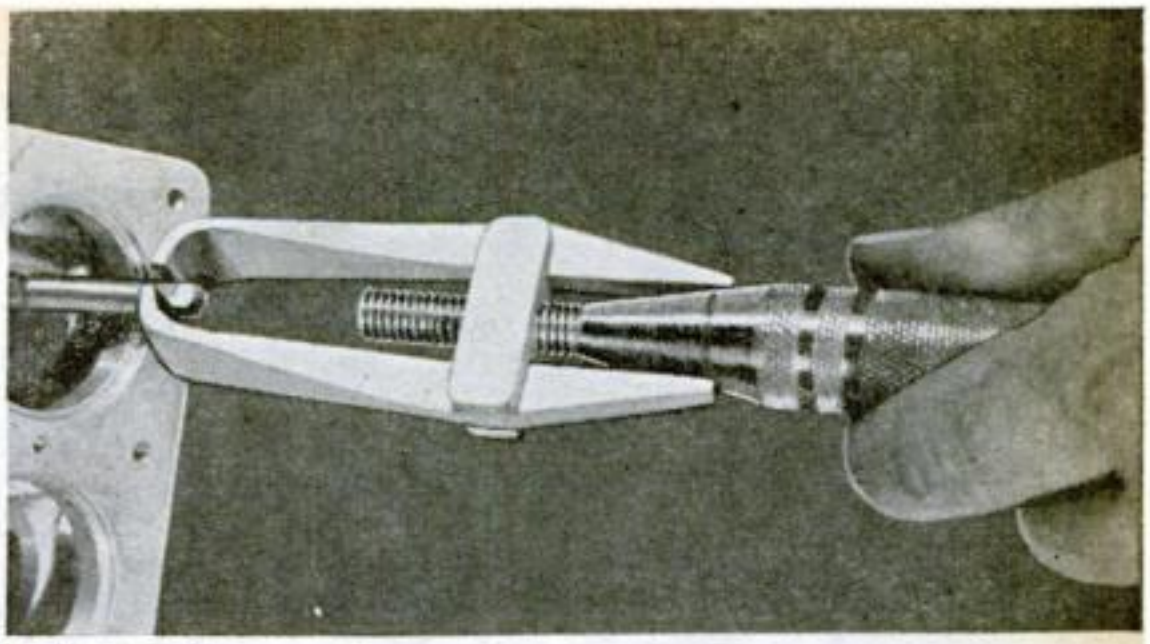




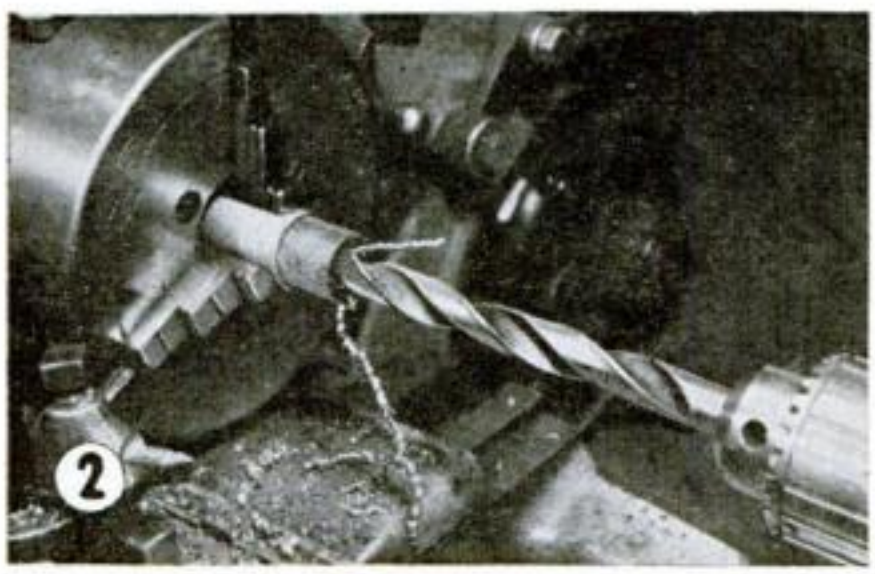
GOOD V-BLOCKS for your drill press can be made from the field pieces of junked auto generators. Turn flats on the outer, rounded parts of two pieces and then rivet them solidly together as shown in the photograph at the left.—SIDNEY POTT.

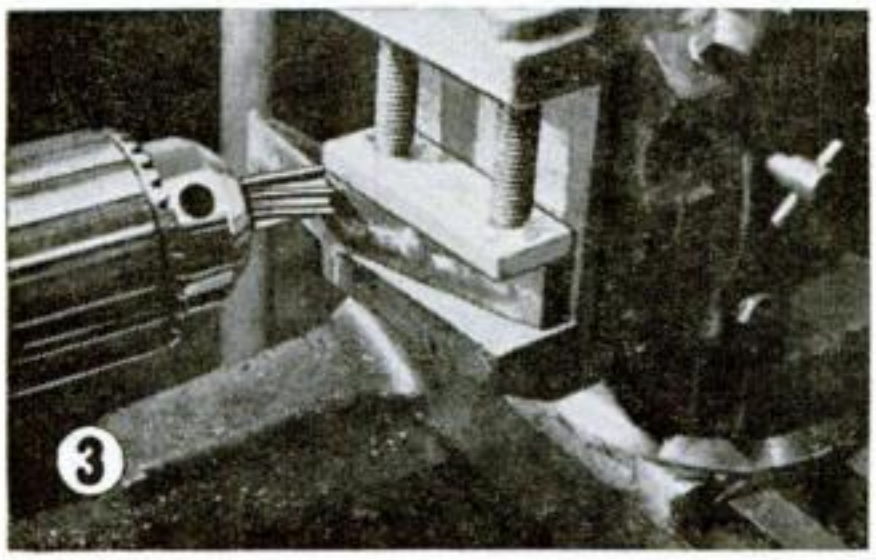
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Sure-Grip Hand Vise







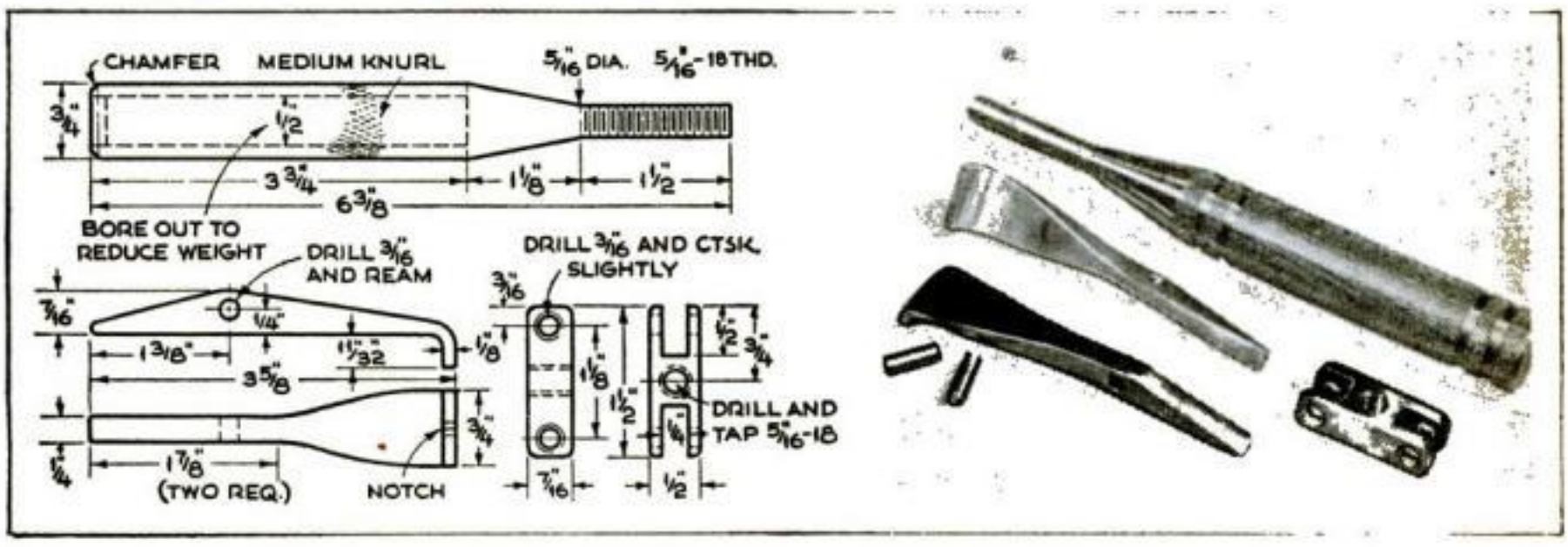


IN SHOPS handling small parts, this vise will have a hundred uses. It will hold parts for grinding, filing, and assembly, get drills, taps, and reamers into corners, and grip wire, pins, and screws. The handle operates the jaws, which open to ⅝".

All parts are machine or cold-rolled steel. Knurl the handle, as in Fig. 1, turn to shape, taking particular care with the taper, and thread in the lathe or with a die. Protect the knurl with soft metal and chuck as shown in Fig. 2. Bore to reduce weight, plug the hole, and face the ends.

The jaws are shaped on a lathe milling attachment (Fig 3), a milling machine, or a shaper; or a drill, hacksaw, and file may be used. They are then drilled and reamed lightly. Cut the pivot block to outside dimensions, drill and countersink for pins, and drill for the handle. Then drill and file the jaw slots to a tight fit, and tap the center hole to fit the handle thread.

Assemble first with loose pins, make final adjustments, and nick the jaw faces at center to help hold small wires or pins. The jaw faces, block, and handle may then be case-hardened. After final finishing, reassemble the vise, rivet in two 3/16" steel pins, and file the heads flush.—WILL THOMAS.



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"Battle Scene," a photo with toys and a manikin as subjects and a projected transparency as background.

My Color Studio is a

By J. CLARENCE McCARTHY

PERHAPS you have found that photographing babies, relatives, and landscapes can become monotonous, even in color. I did—and out of sheer boredom began to dream up pictures and then build them to order.

No, you can't do this sort of thing with a box camera on a rainy Sunday. You must have a reasonably good camera built for color—preferably, because of film cost, a 35-mm. one. You need a slide projector, lights, a work table, and elbow room. With these, a dash of ingenuity, and a generous portion of perseverance, you will be ready for a form of color photography in which you can make good use of some of your pet transparencies.

Where will you get the ideas? Well, you'll probably start with some favorite color shot—a gorgeous sunset, a breath-taking scene above the clouds snapped from a plane, or a lucky exposure of a snow-capped mountain. Thinking of such a picture as a potential background, simply turn on the imagination. If the creative bump needs nudging, you will find suggestions in newspapers, magazines, and even comic strips.

To translate these dream children into color pictures, you will need a layout similar to that shown on the facing page. You could do with a table 4′ by 6′ instead of 4′ by 12′ and use a separate stand for the projector. The larger table, however, is convenient as a work space between takes.

For the screen through which the backgrounds are projected, I use a sheet of light, translucent 1/16″ plastic in preference to frosted glass, which is heavy and breakable. The projector is a standard make equipped with a 300-watt lamp.

Working with sets averaging 4′ by 4′, you will find difficulty with standard lighting equipment in confining the light, so that when you get enough in dark areas you won't be burning out the delicate flesh tones of your manikins and the high lights needed

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for accent. For basic lighting I frequently use standard reflectors overhead and diffused and similar lights for fill-ins, directing them on the dark areas. To high-light figures and other important objects, I employ slide projectors equipped with bluish filters of the kind used in commercial photography. This assures color temperature equivalent to photofloods.

A black velvet curtain is a most useful accessory since double—sometimes even triple—exposures are required to get the set and the projected background on one film. With the curtain, the background can be blacked out during exposure for the foreground, and the area on which the background will appear will not be pre-exposed. My curtain is rigged with light ropes and awning pulleys so that I can control it without leaving the camera.

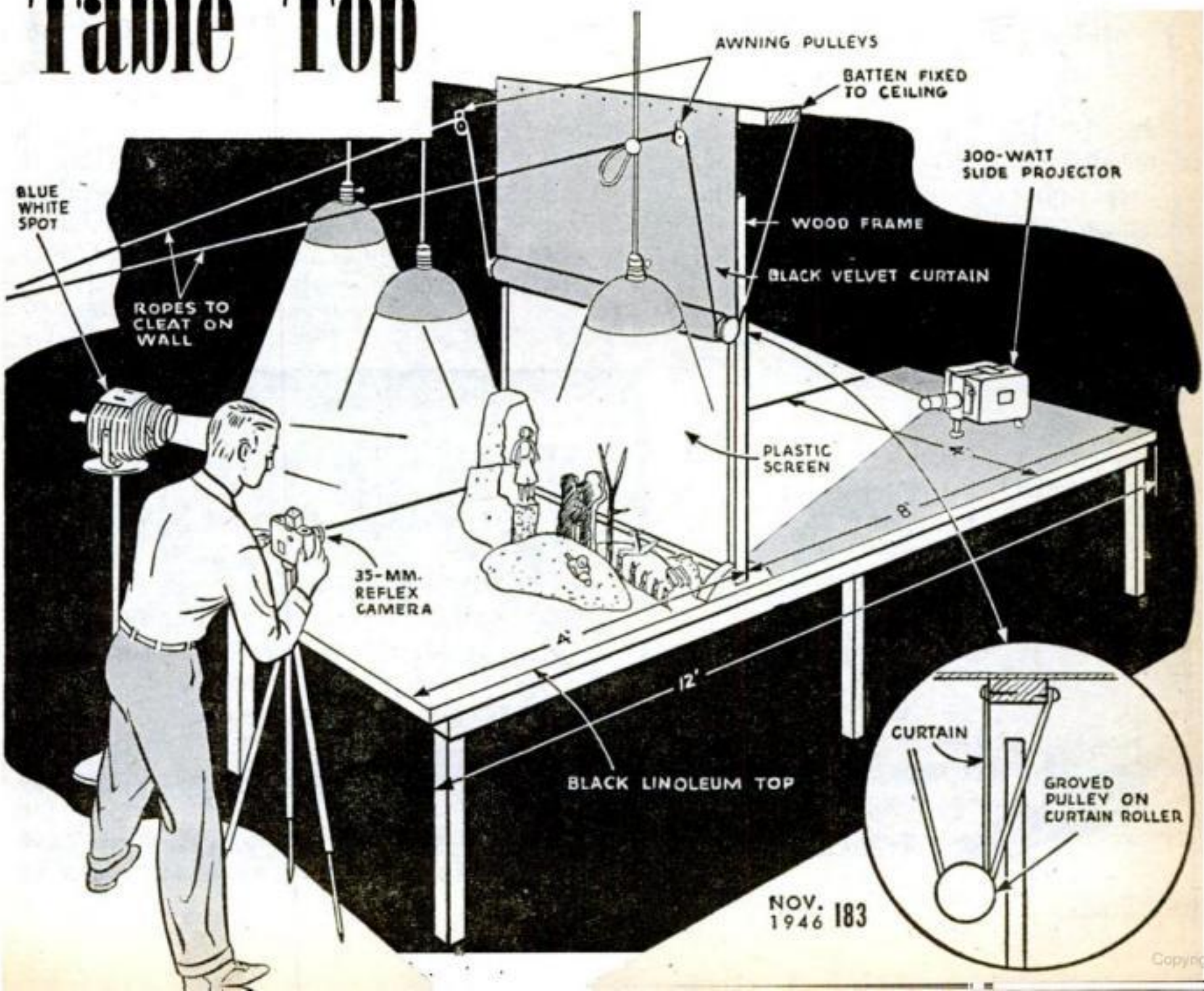
I shoot the foreground set first with the curtain covering the screen; then I reset the shutter, raise the curtain gently, "kill" the set lights, switch on the previously focused projector, and expose for the background. Extreme care must be taken not to jar the set or the camera.

There seems to be no sure method for calculating exposures for backgrounds. The foregrounds, of course, can be metered; but each slide differs, and you'll just have to try and try again. Simple exposure records of each take are helpful—in fact, they are a necessity.

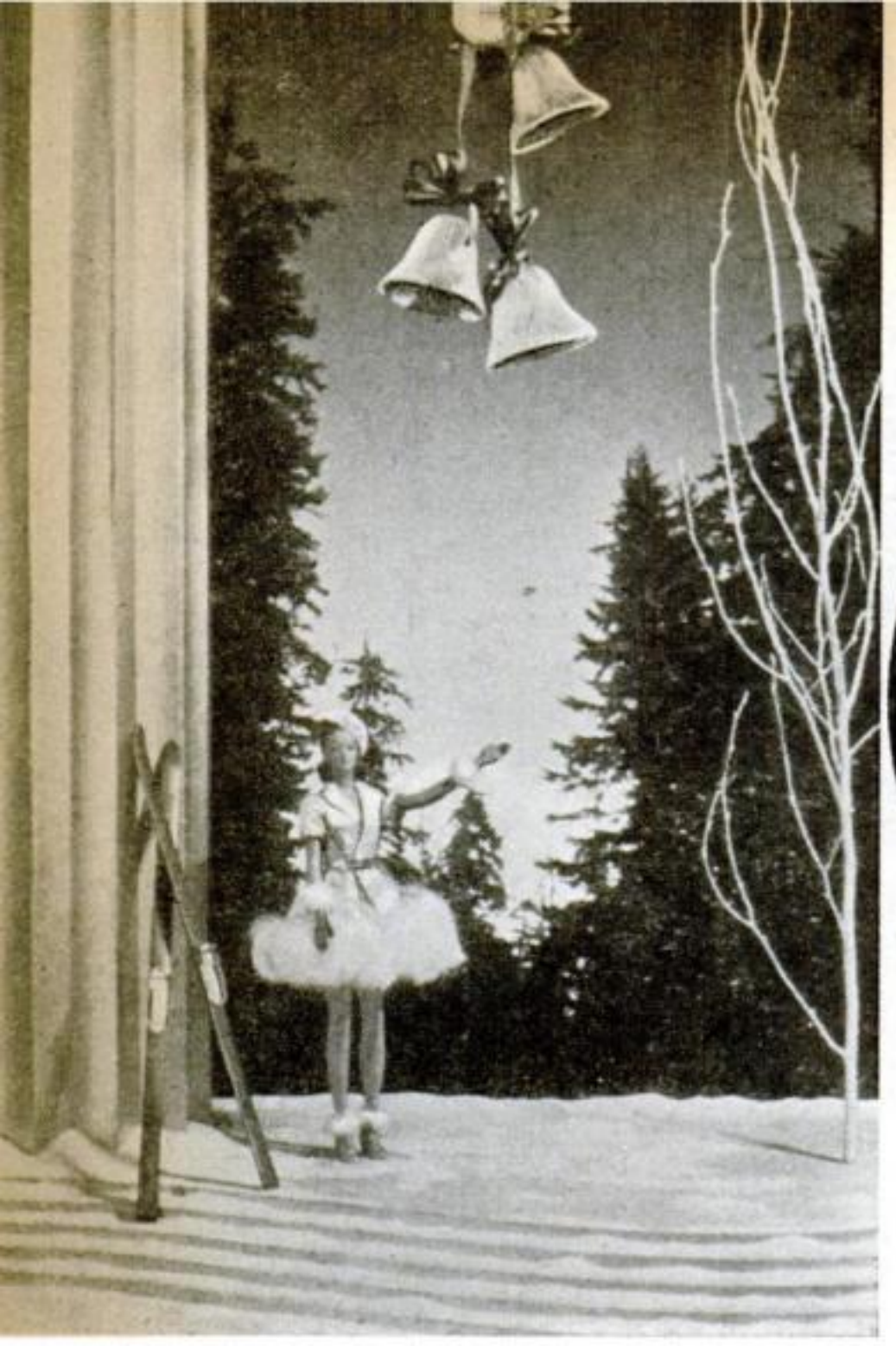
Building and assembling the sets can be simple or tricky. "She with Skis" on page 184 (shown in color on page 113) was not difficult. Strips of ¼" plywood were sawed for the steps, topped with a broader piece, and covered with blue paper. The column was silver-surfaced window-display board, fluted by scoring the back and folding. Salt was used for snow, the bells were obtained from a florist, and the foreground tree was a dead branch painted white. A friend whittled the skis, and another dressed the manikin, which is 11" high and was obtained from a display house. The set measured 20" deep by 28" wide by 36" high, allowing plenty for cropping.

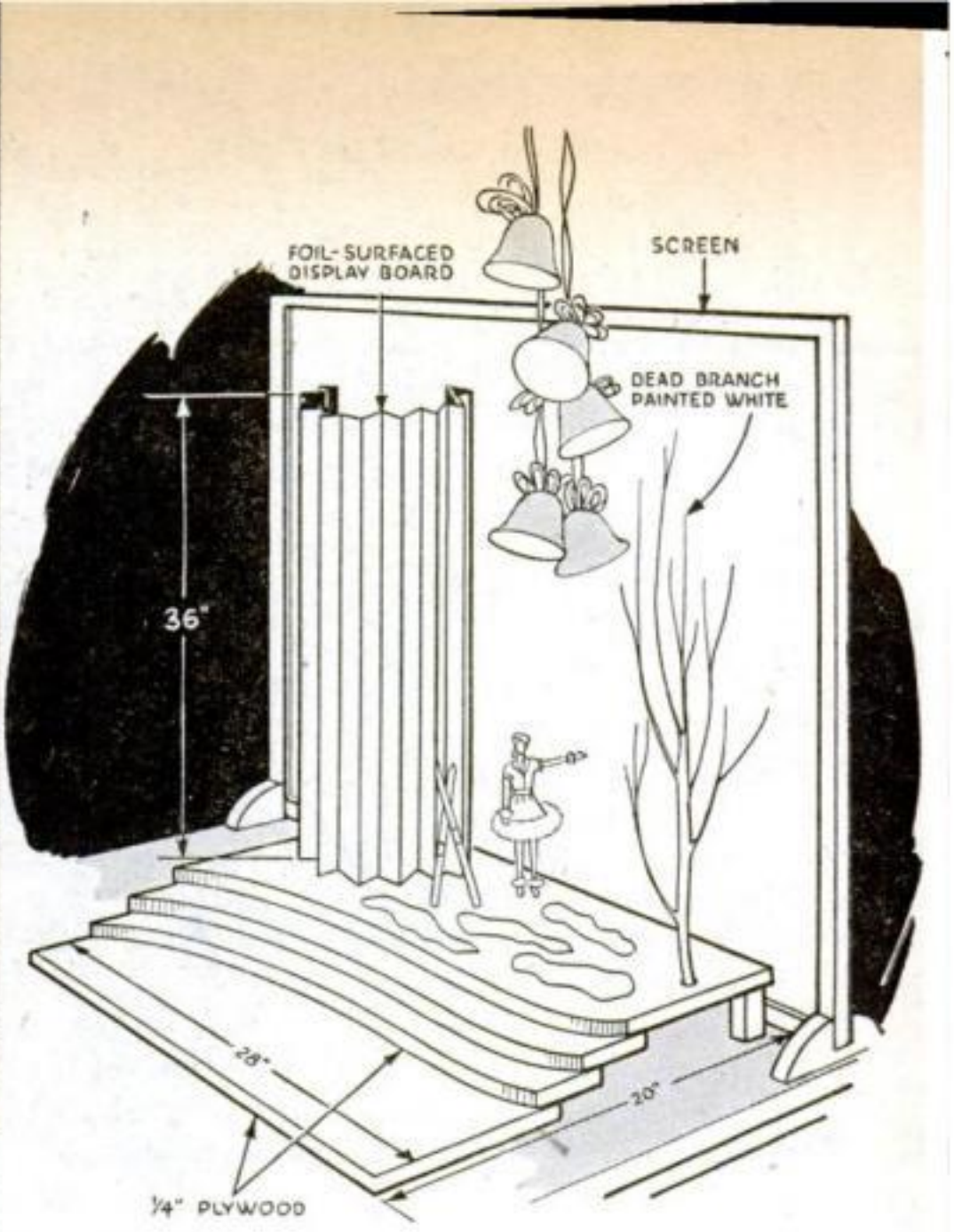
Lighting was that described before, with the addition of light-blue cellophane in front of two photofloods. This gave the desired cold effect for a snow photo. The background,

Table Top



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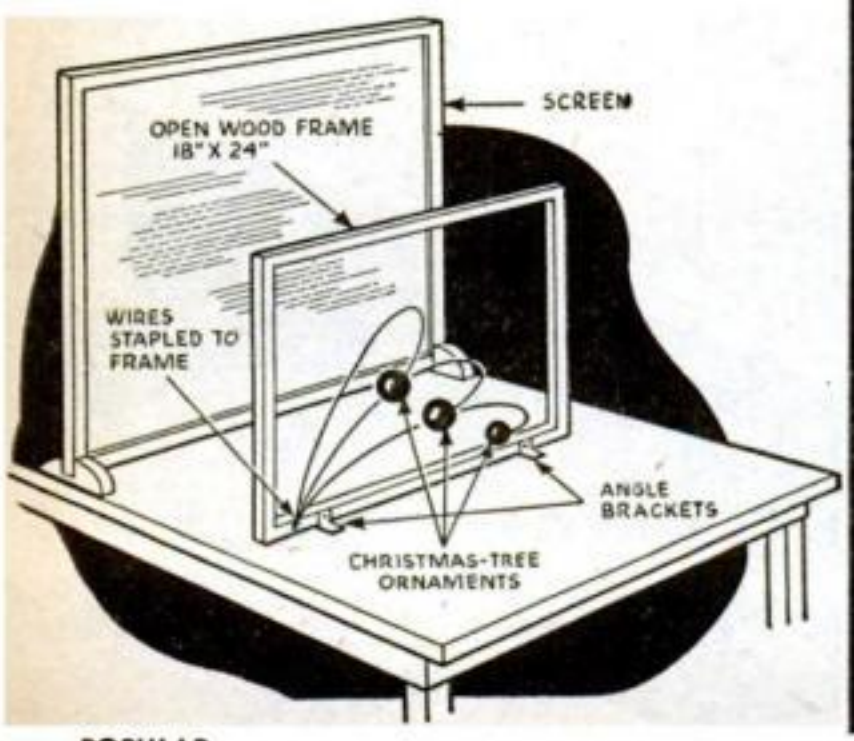


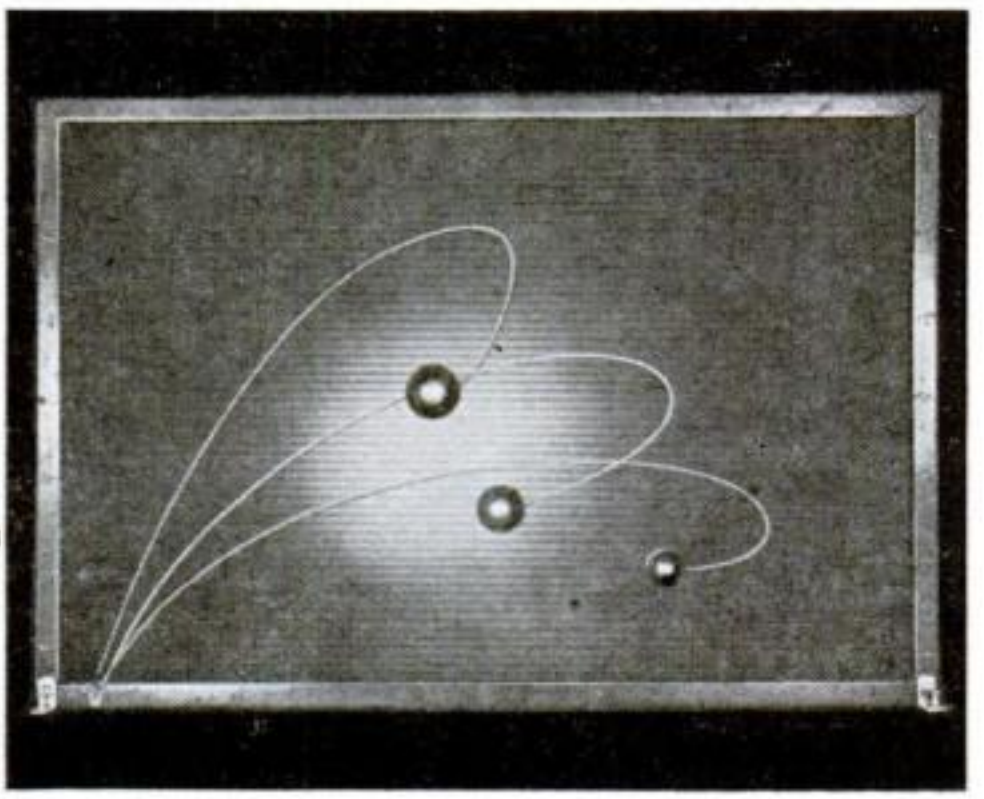


What you get and how you do it. At left is the finished picture; above, the table-top set used in making it. The full-color shot is on page 113.

and incidentally the inspiration behind the whole setup, was a treasured shot of Mount Rainier. Exposure for the foreground was ½ sec. at f/15. The projected background required 5 min. at f/11.

"Stratosphere over Harlem," on the facing page (and also in color on page 113), was born one day when I saw the pickaninnies staring up at me from a counter at Macy's and asking to be "sent out of this world." To "conjure" the clouds, I used two uprights, one at either side of the table, with arms jutting into the picture plane. Cotton batting was tacked on with white thread and fluffed. A color shot above clouds taken from a plane was projected for the background. Light-blue cellophane taped over the slide added to the effect of distance.





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One blue light was mixed sparingly with white, and a concentrated white projector spot was trained on the figures. Exposure for them and the clouds was ½ sec. at f/10. The background got 3 min. at f/11.

Building the battlefield for the set on page 182 took a bit longer. For the hills I used garden loam over a roasting pan, with wood blocks for fillers. The shattered house was painted on cardboard, and the tree was a dead branch. Soldiers, plane, and tank were found in a toy shop. The rock on which the nurse is standing is the genuine article. For my money, nothing photographs so much like rock as rock.

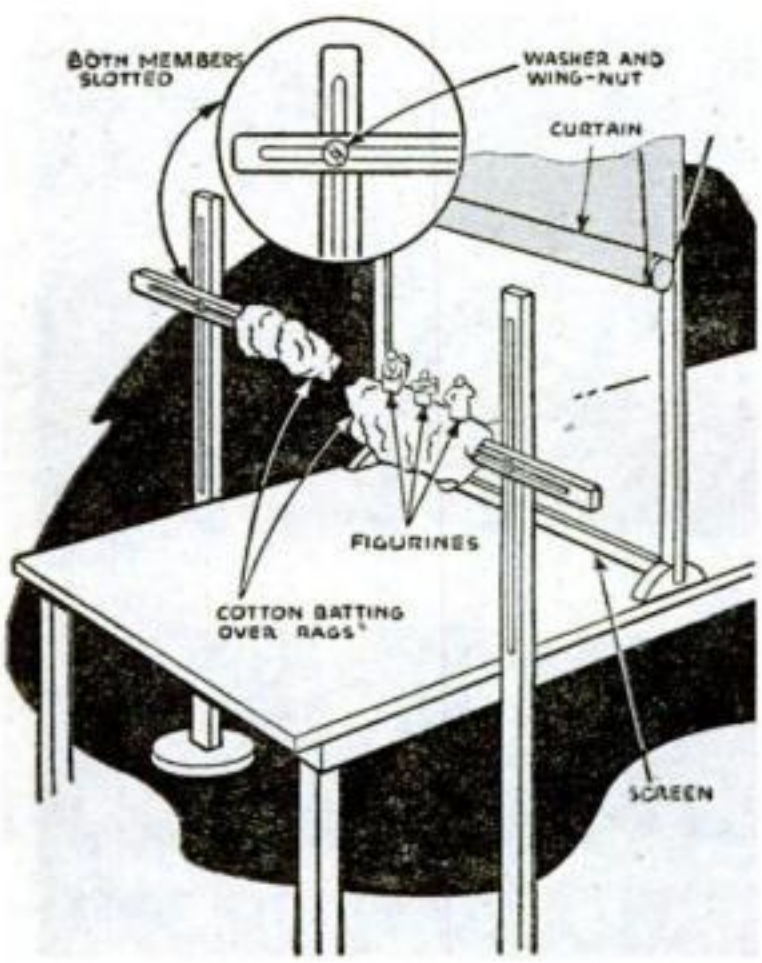
Since I wanted an eerie night effect and planned to light with a minimum of white mixed with blue and green, I sprayed the ground a medium blue-green. For the background I used a slide of a sunset covered with light-green cellophane to fake the night sky. The fire glow was achieved with a 3-watt lamp wrapped in orange cellophane and planted behind the screen below the line of the hill. This was a separate exposure of 1 min. 15 sec. at f/11 following the exposure for the sky background, which was shot 3 min. at f/11. The foreground exposure was 4 sec. at f/11. A blue-white projector high-lighted the nurse.

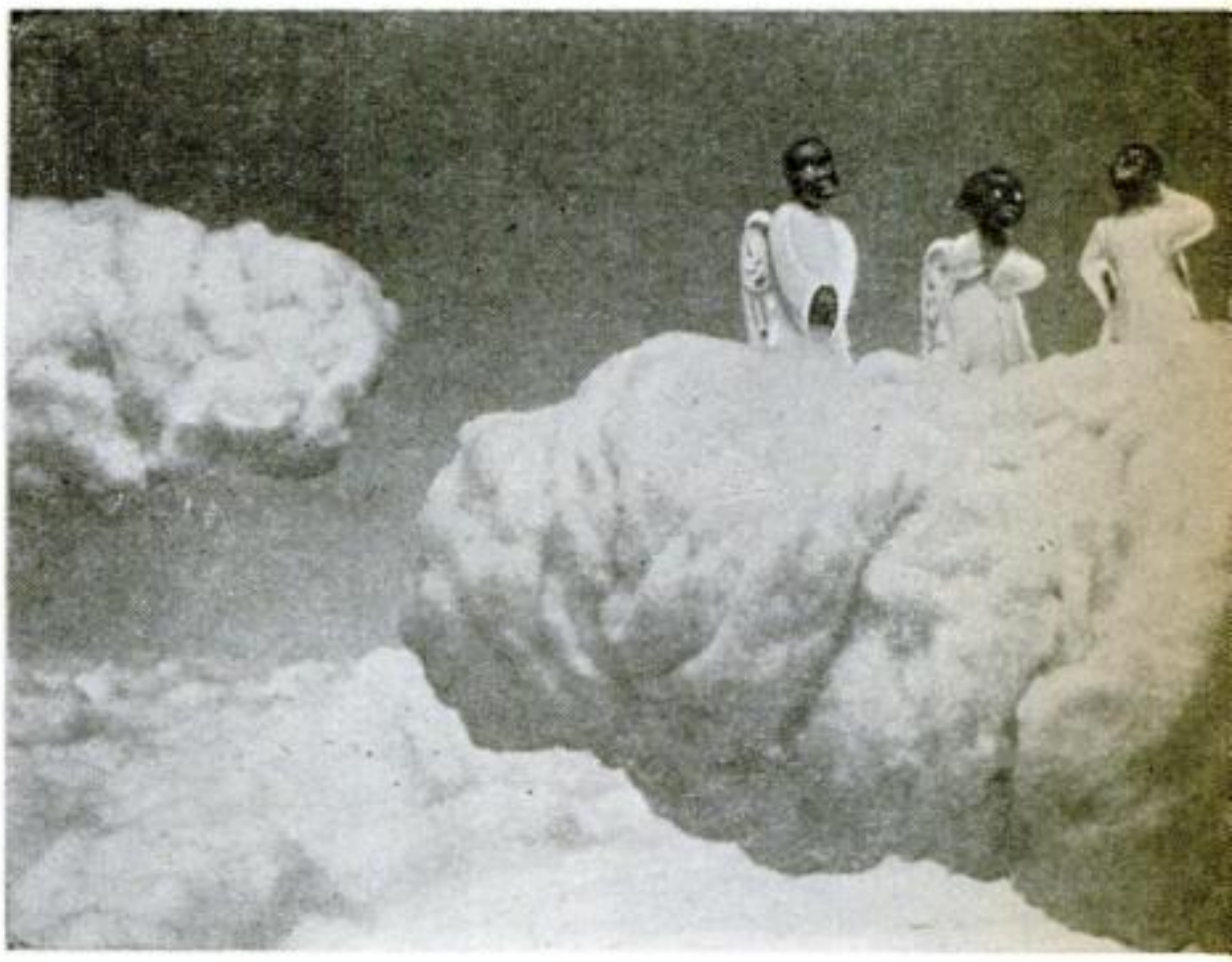
Now that you're in the mood, let's flit from the world of make-believe to what some might call abstract art but what might better be known as doodling with the color camera. If you have a double-jointed imagination, the three examples shown are the kind of things you do merely for the love of it—and to keep out of trouble.

For the creation with the three gold balls on the facing page and on page 113, I simply bent wires to shape, painted them, and stapled the ends to a wood frame held upright by brackets. The balls were Christmas-tree ornaments cemented to the wires. For the background I made a 35-mm. slide by photographing gray corrugated board high-lighted with a spot. The wires and balls were lighted conventionally and photographed with the black velvet curtain over the translucent screen. Exposure was 2 sec. at f/11. With the curtain raised and the background projected, the second exposure was made in 1 min. 15 sec. at f/11.

The confection with the graduated green balls and whirlpool effect on page 186 was an interesting experiment. This whole set had to be scaled to the wooden balls. First, I took an 18" by 24" piece of black cardboard and cut a rectangular opening. Sections of heliotrope-painted corrugated board were pasted at the side and bottom of the opening. The painted balls were then cemented to stiff wire doubled back and cemented to the back of the cardboard, and the assembly was tacked to a wood frame.

For the whirlpool, a slide was made by shooting close-up into the bottom of a swirled tumbler lighted indirectly. To model





These clouds are cotton batting supported on wooden crossarms, and the figures are dolls. The film was exposed twice—once with the background blacked out.

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Three exposures were required for this abstraction—the first with only the Christmas-tree lamp lighted.

the balls and bring out texture, 45-deg. lighting with fill-ins was used, and the exposure was 1 sec. at f/12. Then the projected whirlpool was exposed 30 sec. at f/11.

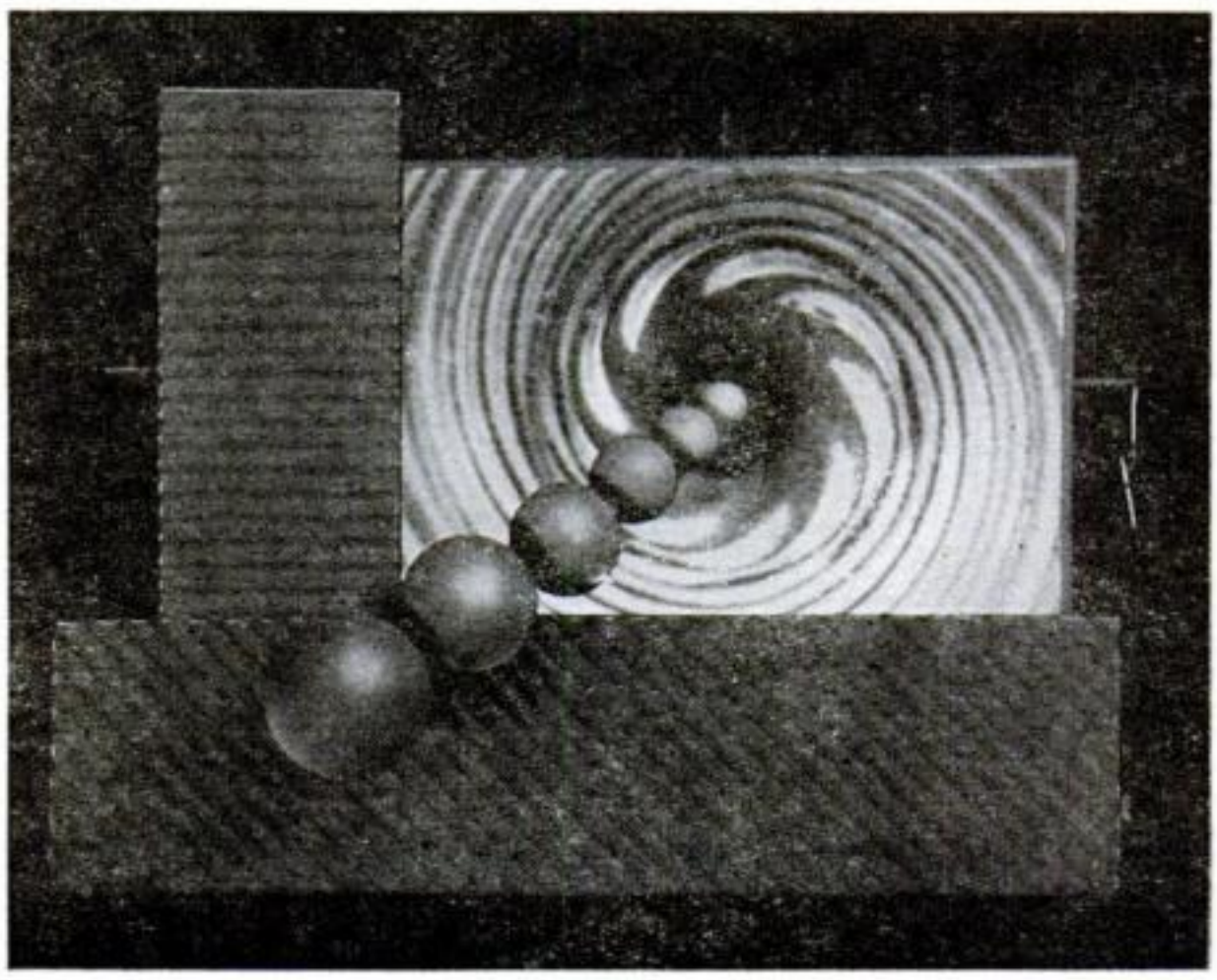
A lily-shaped metal vase suggested the subject above. Its frame was clear plastic in an outer plywood frame bracketed to the table. A Christmas-tree lamp was wired in the vase, which was then mounted on a wood block along with three plastic tubes wired to shape and topped with imitation pearls dabbed with metallic paint. Draped green velvet completed the composition. The background slide was made by photographing textured glass illuminated from behind with blue lights to bring out its lines.

Lighting was a bit tricky, requiring sufficient light on the velvet without burning up the plastic frame and the vase. A flood close to the right of the set between the frame and the screen was the basic source.

Three separate exposures were required to get the finished effect. With the background screen curtained and the main lights off, an exposure of 3 sec. at f/8 was given the lighted lamp in the vase. The second exposure with all lights except the Christmas-tree lamp was 1 sec. at f/9, and the projected background was shot at f/8 for 1 min. 35 sec.

These "doodles" are only a warm-up. The possibilities are unlimited. Besides getting a lot of fun out of them, you can explore the potentialities of the color camera in illustration, advertising, and abstract decoration.

You may ask yourself, as some of my friends asked me, "So what?" If you insist on being practical, I can tell you that table-top color photos can be, and have been, used for magazine-cover illustration. I have a hunch, too, that they may have a place in the field of fashion photography, where they may be found a means of obtaining effects that would be prohibitively costly with full-scale sets and live models. As for the abstractions—well, you won't exchange anything for the thrill of turning out pictures nobody else can.



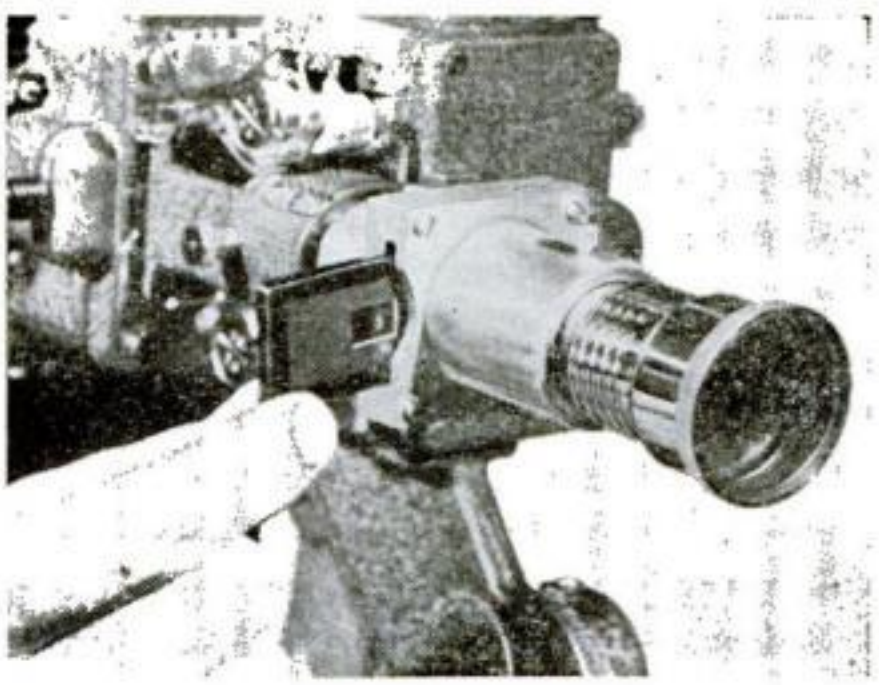
This whirlpool shot is really a simple setting. The frame is of two kinds of cardboard, and the set of balls is wired in place. A transparency of a lighted, swirled tumbler provided the background.

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PHOTO IDEAS and EQUIPMENT

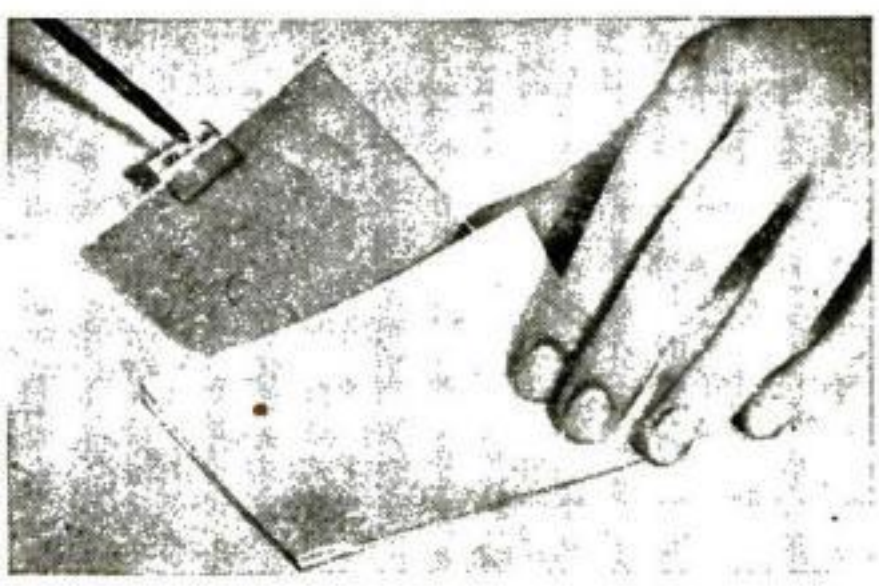


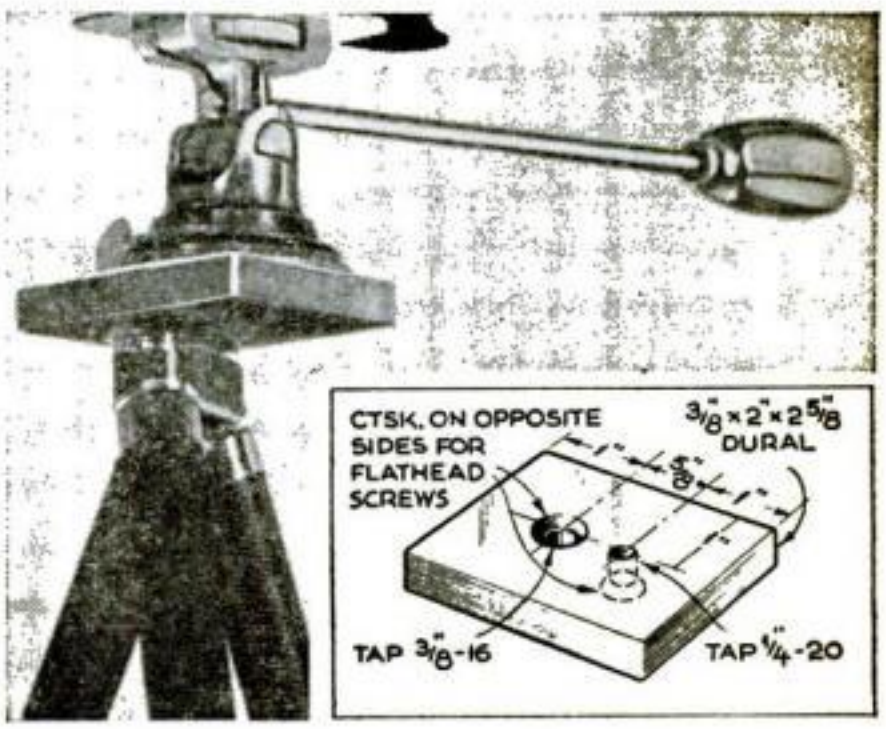
SLIDES OF 16-MM. FILM can be shown by a movie projector with the addition of an easily mounted accessory that requires no mechanical changes and will not interfere with the running of movie films. The attachment in the photo below is a product of Projecto-Slide Co., of New York, and is packed with material for making 25 slides at home. Refill kits of slide material are available. With the equipment, selected scenes may be cut from 16-mm. color or black-and-white film for making slides.



AIR-BUBBLE "PINHOLES" are less likely when developing negatives in a daylight tank if you fill the tank with developer first and let the bubbles work out before putting in the film. To determine the level to which the tank must be filled, put in an empty reel and add water to fill the tank. Then, when the reel is removed, the water level can be marked and later painted in permanently.—HENRY HANSCOM.

TABS ON FILTER GELATINS provide a convenient "handle" and prevent damage to the gelatin from finger contact. Make the tabs of 1″ strips of transparent cellulose adhesive tape, attach the ends to the front and back of the upper edges of the sheet, and press folded. For identification, insert a number on paper.—K. S. J.



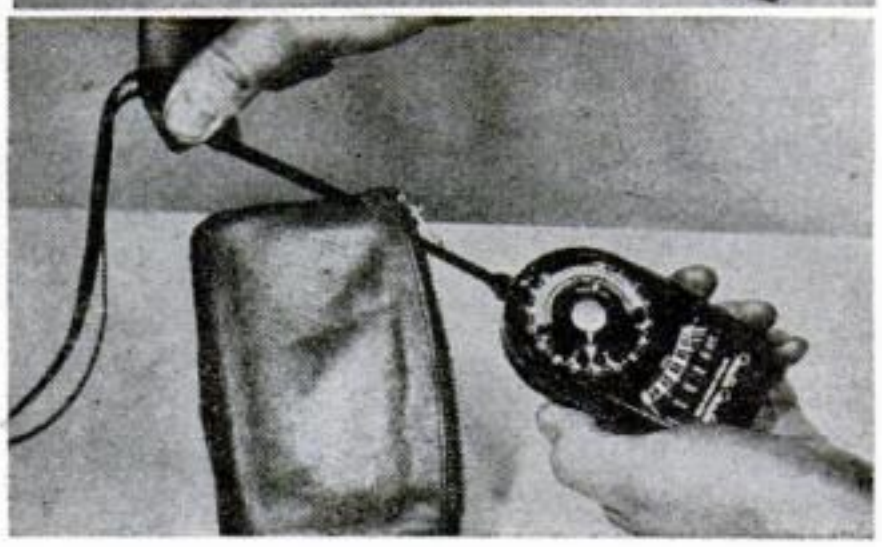


THIS TRIPOD ADAPTER lets you use an American camera on a foreign tripod and vice versa. Drill and tap ⅜″ duralumin for a ⅜″-16 machine screw (foreign size) and a ¼″-20 screw (domestic size). Countersink one hole on one side and one on the other. Use a screw to fit the camera and cut it off so that it extends only ¼″ beyond the base plate.—DALE W. ANSELL.

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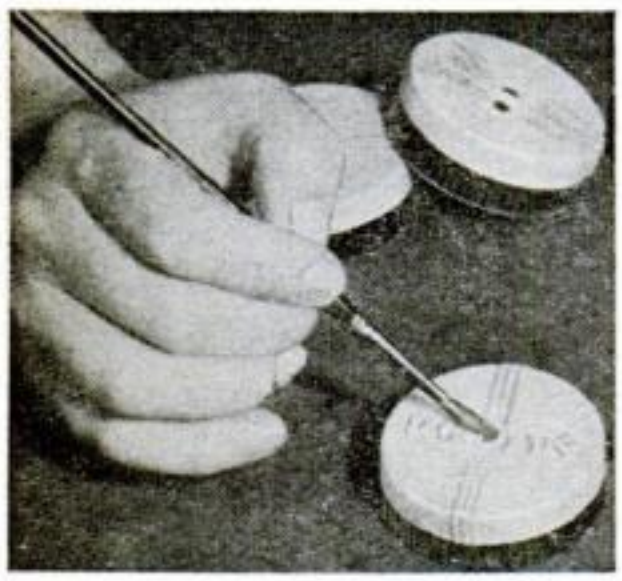






AN EXPOSURE-METER CASE that can be hung around the neck and slipped into a pocket, as above, can be made from an ordinary tobacco pouch having a slide-fastener opening. Staple a protective rectangle of heavy cardboard to the inside edge of each side, as at top right, and cover the ends of the staples with adhesive tape to keep them from scratching. Punch a hole through a corner of one side and slip through it a doubled cord, the ends of which are attached to the exposure meter, as shown in the photo at the lower right.

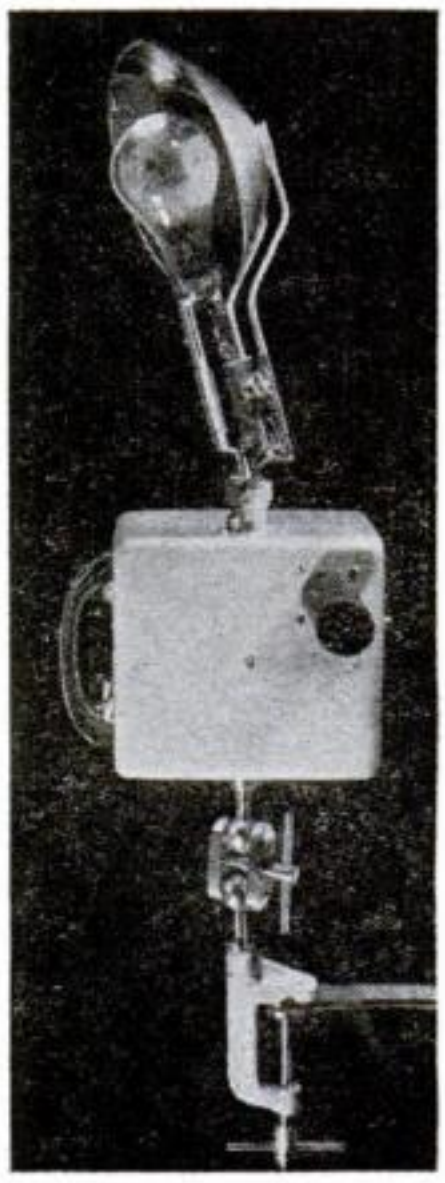
In use, the cord remains about the neck, the slide fastener is opened, and the exposure meter is removed for taking necessary readings. The pouch will remain hanging on the cord and instantly ready for reinsertion of the meter when the readings have been completed.—H. LEEPER.



COLOR IDENTIFICATION of filters packed in uniform cases is easily made with spots of the color painted on the case. Two yellow spots identify a yellow filter with a 2x exposure factor, a green spot and a semicircle a green filter requiring 1½ times normal exposure, and so on. Transparent oils for coloring photographs are suitable.—K.S.J.

ELECTRIC-EYE FLASH is the latest development in multiple-flash photography. The master flash bulb is set off at the camera as usual, but instead of having wires strung to it, each synchronized or "slave" bulb is mounted on a 4″ by 6″ by 6″ box in which a photoelectric cell picks up the light from the main flash. To avoid time lag, the electrical charge emitted by the cells forces faster burning of the supplementary flashes, and master and slaves reach their peak light simultaneously.

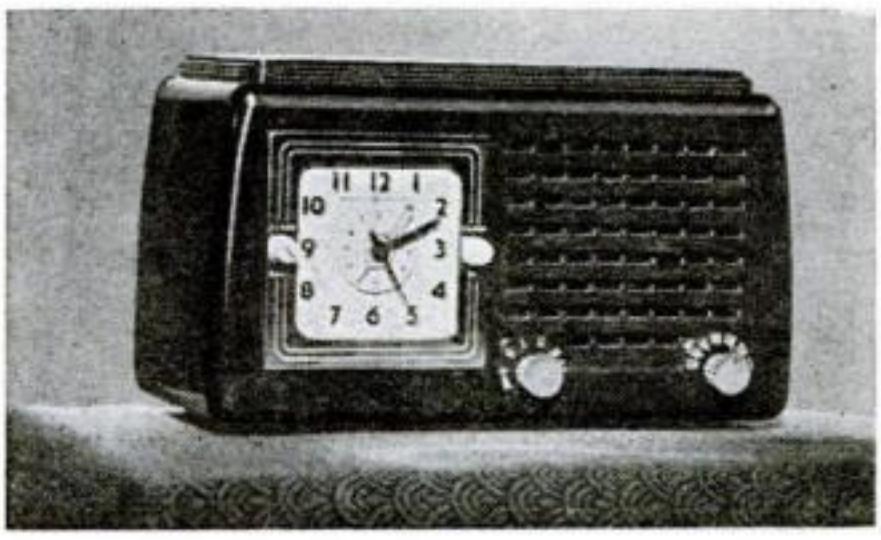
Each auxiliary unit is mounted on a double-swivel C-clamp that simplifies light placement and direction. The units, known as Synch-Check, were developed by A. K. Edgerton and introduced to the market by Hod Lewis Associates, of Hollywood.



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NEWS IN ELECTRONICS

MUSIC WAKES YOU UP with this alarm clock-radio combination. The clock turns on the radio to any preselected station at any preset time. An extra resonating alarm speaks up a few minutes later to make sure you don't roll over and let the music lull you back to sleep. The two-in-one set, a boon for easily startled sleepers, is manufactured by General Electric.

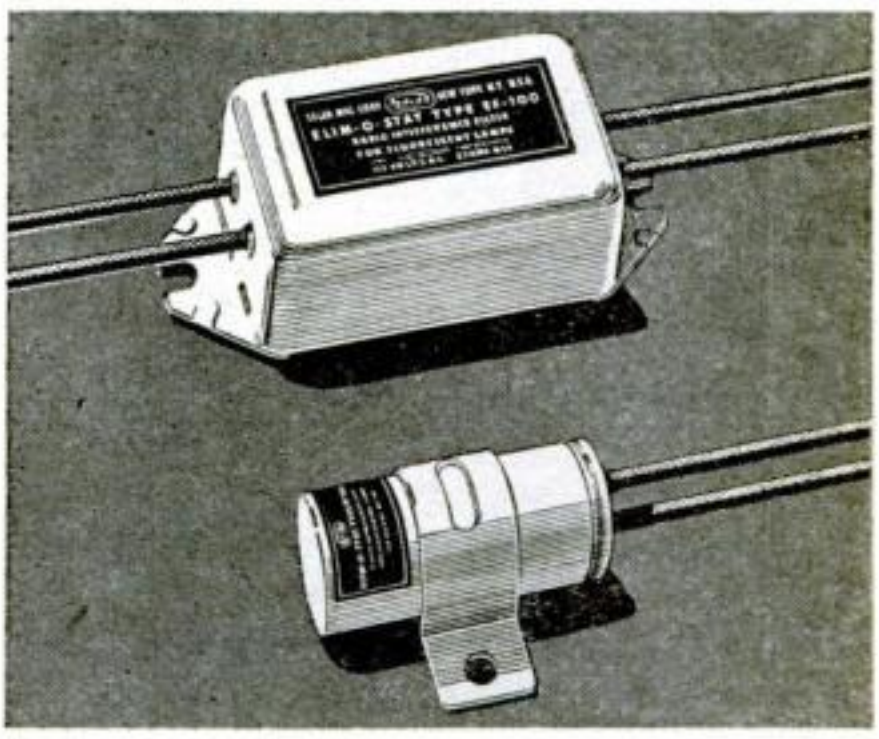




ELECTROMAGNETIC RADIATIONS can be demonstrated in the classroom with the aid of the GE microwave oscillator above. The self-contained 4-lb. unit is designed as an aid in teaching the fundamentals of ultra-high-frequency communication, including such phenomena as polarization, reflection, standing waves, and refraction.

AN EXPANDABLE AMPLIFIER for public address systems has extra units that can be added to the basic case, increasing amplification two to nine times. A record-player and changer section can also be attached when needed. Concord Radio Corp., of Chicago, makes it.





RADIO INTERFERENCE from fluorescent lamps may be diminished or eliminated if the offending lamps are equipped with filters of the type illustrated above. These are made by the Solar Manufacturing Corp., of New York. Static generated by the increasingly popular lights is said to be responsible for a good deal of distortion of television images.

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With the latest disks and even later music off the airwaves, you're equipped for any party—anywhere.

Portable Phono-Radio Combination

By GEORGE O. SMITH

FOR CANNED or current entertainment, here's an all-around music box that will keep you in the swing. Built into a small case that usually holds only a phonograph, this set contains a five-tube superheterodyne receiver that can be used alone or as an amplifier for the record player. The radio operates on A.C. or D.C., making the unit useful wherever 115-volt current is available. A universal motor would give the record player an equal amount of flexibility, but since one may be hard to come by, either an A.C. or D.C. motor can be used in its place. In this event, of course, you will have to see that the phonograph part is not used on the wrong current.

To get the radio into a small cabinet, the tubes and intermediate-frequency transformers are mounted on one edge of the chassis. This "in-line" layout fits below the phonograph motor and tends to isolate several of the oscillation-producing components. A standard 1½" by 5" by 9" blank is used for the chassis, but a satisfactory substitute can be formed from 20-gauge steel or aluminum. Aluminum may be better if heavier stock is used, and it should offer no soldering difficulties since connections to the chassis are made with lugs. The complement of tubes and transformers will fill the edge of the chassis with no room to spare, so, as a step in space conservation, use spring-type tube bases; these fit into mounting holes of approximately 1 5/32" diameter and are secured by retaining clips.

The rest of the layout will depend upon the space available in your cabinet. In mounting the gang condenser, don't forget to allow for the swing of the rotor plates. It may be possible to make a direct coupling in some cases; in others, a flexible coupling or flexible shaft must be used. The latter will allow the condenser to be mounted at some distance from the dial. If none of these methods is feasible, you may have to resort to the dial-cable system shown in the photograph at the top of page 192. Cut the condenser shaft short of the front panel, and fasten over it a knob with straight sides. Build up the hub of the dial assembly with tape or a metal bushing, and wrap the cable around it. To secure the cable ends, replace the knob setscrew with a longer screw of the same thread, slotted at one end. Tighten the knob with this screw, pull the cable firmly through the slot, and solder it fast.

When cutting the board for the phono-

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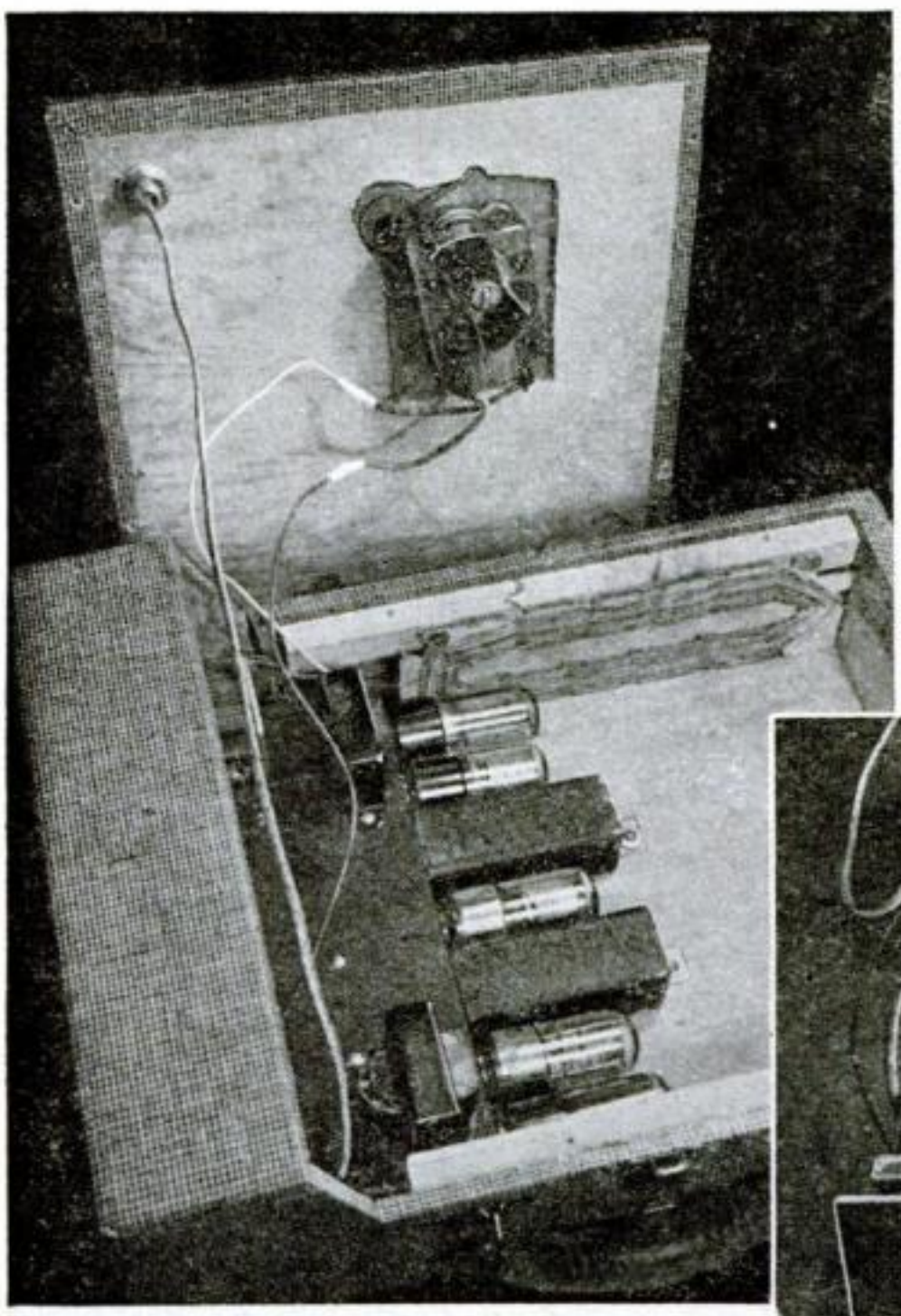
graph motor and turntable, it is necessary to place the disk over to one side in order to leave enough room for the pickup arm. Try out the position of both units with the largest record you expect to use before drilling the board.

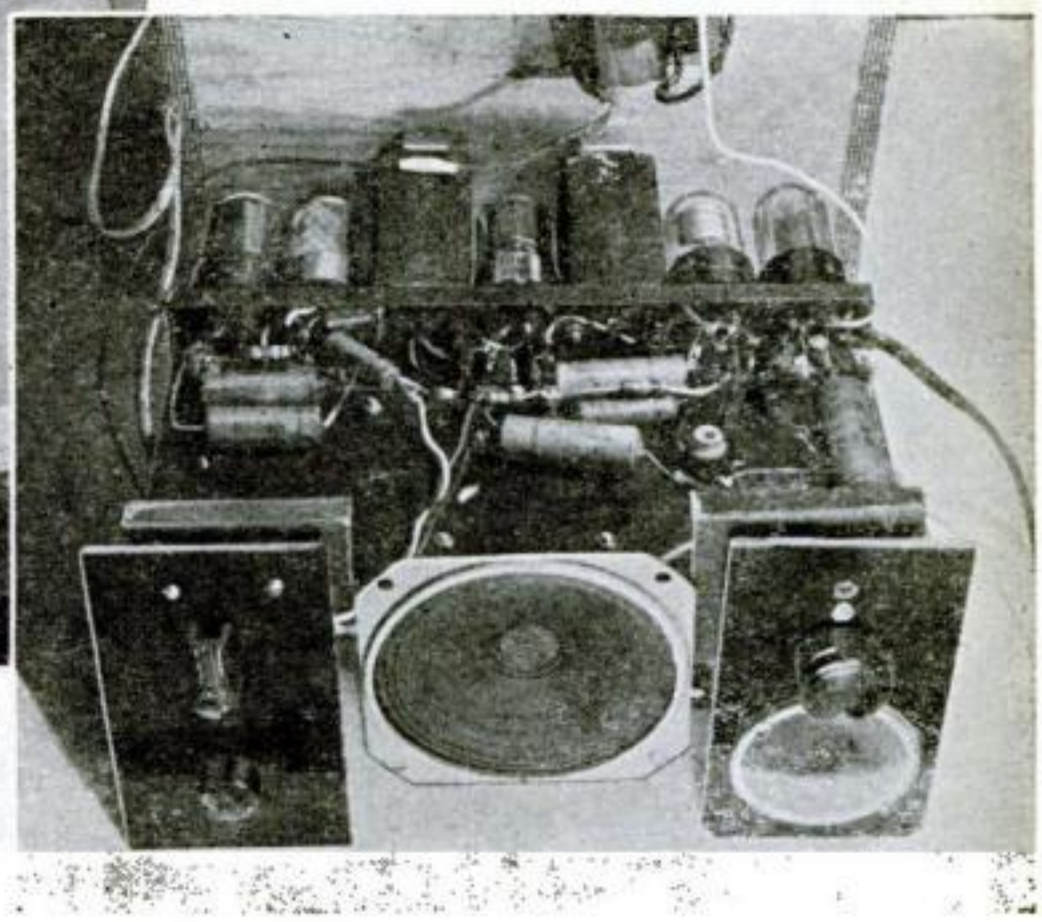
The recessed-control panel eliminates the protruding knobs that may either become damaged or do damage during transit. Separate rectangles are cut out of the cabinet front, and the panels holding the dial and control knobs are fastened behind the openings. If you have a large sheet of bakelite or other material suitable for use as a panel, you may prefer to cut a single rectangle long enough for the speaker and both control sections. Whichever way you do it, be sure to leave finger clearance around the knobs.

Remove the crystal cartridge from the pickup arm by taking out the two screws on the sides. The cartridge probably has two lugs used in making connections to the amplifier, and a third, grounded lug which is usually riveted to the case and soldered to one of the connecting lugs. Unsolder this connection. Using two-conductor shielded cable, run the shield to the cartridge-case lug, and the two wires to the crystal-element lugs. These connections will isolate the circuit from the chassis and pickup arm.

With great good luck you may be able to find a manufactured loop that will fit your cabinet. In the more likely event that you can't, a plan for the loop is shown in the photo and drawing at the bottom of the next page. Follow the pattern as closely as possible; if you must revise it to fit your carrying case, alter the internal dimensions proportionately. Cut the form from heavy cardboard or medium fiber, making an uneven number of slots so that the alternate turns will cross above and below each tongue. Wind the loop with No. 22 silk-covered wire; be sure there is an enamel coating on the wire, for the thin silk insulation may part where the wires cross, and an uncoated wire would cause shorted turns. After winding, either paint the loop liberally with coil dope or immerse it in melted paraffin to keep moisture out.

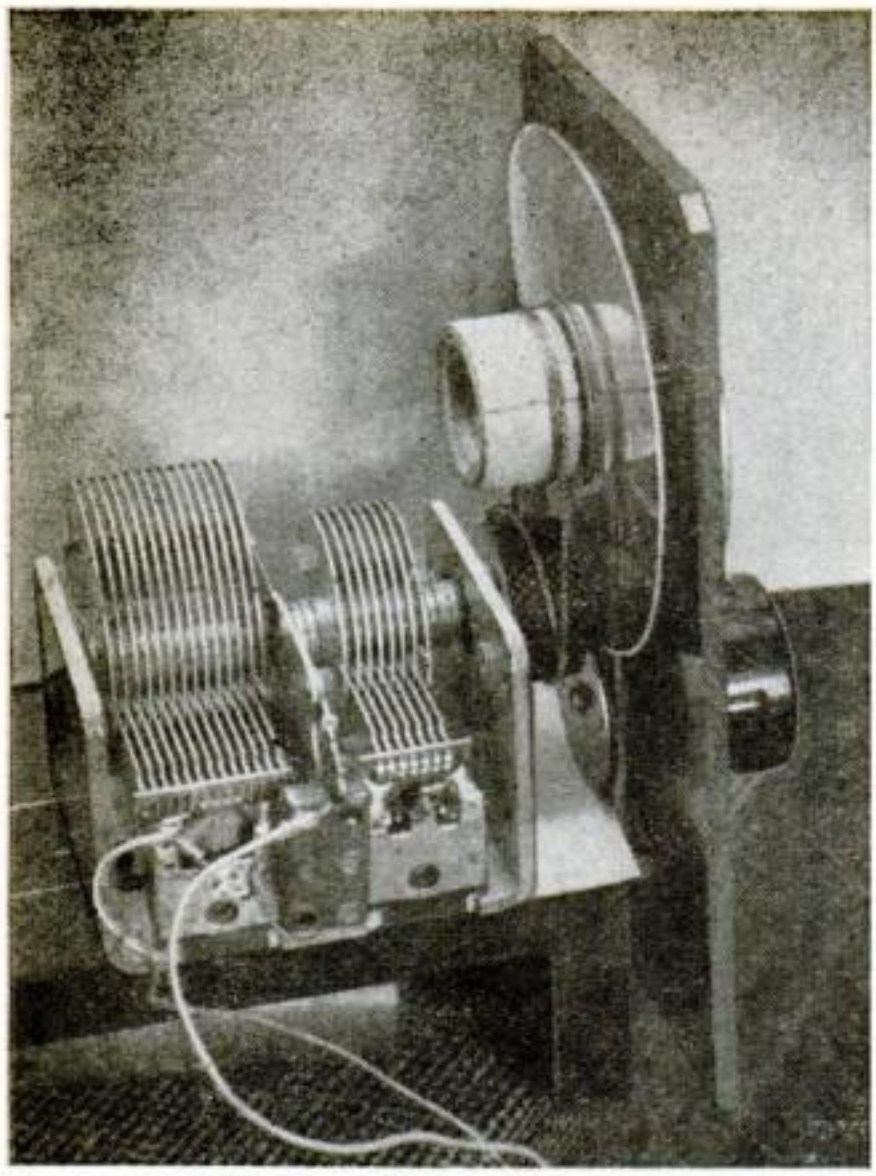
The three-position, four-pole rotary switch turns on the radio in one position, turns everything off in another, and in its third slot operates the phono amplifier and the motor. Pilot lights illuminate the radio dial or the turntable area, depending upon which part is in use. Hum pickup is min-

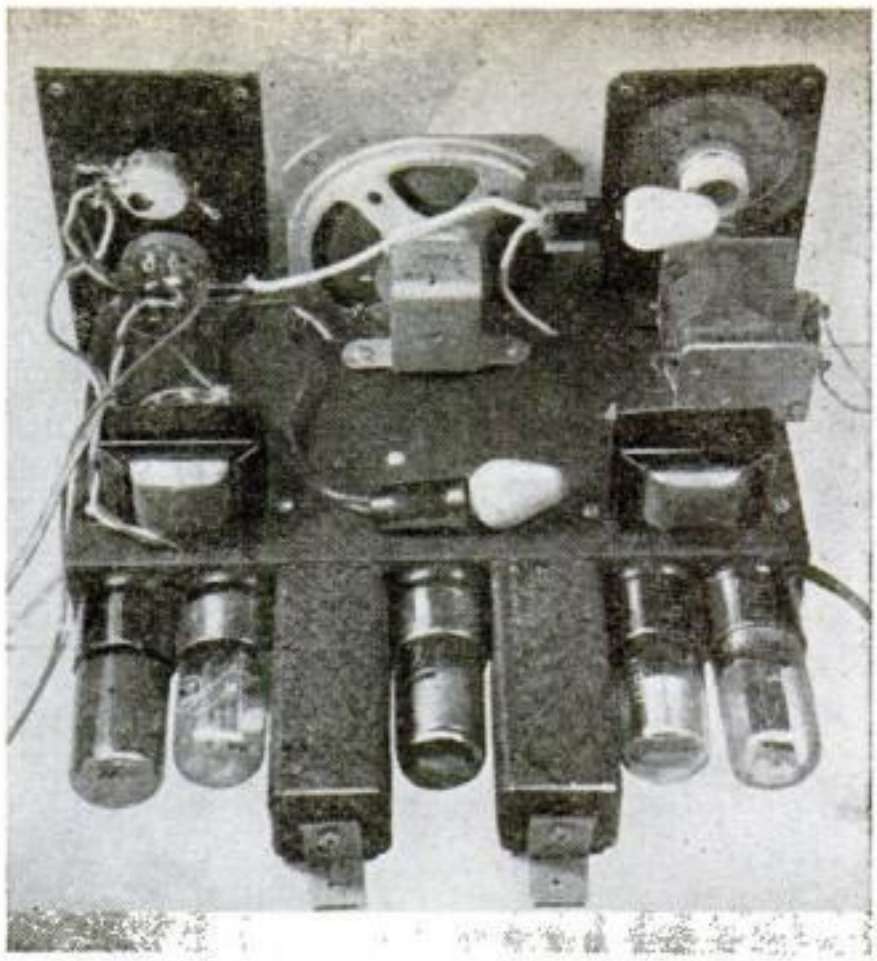




The "in-line" radio-amplifier layout utilizes the normally wasted space in front and below the phonograph motor. Tubes are mounted along one edge of the chassis, with the speaker and control panels fixed along the opposite edge.

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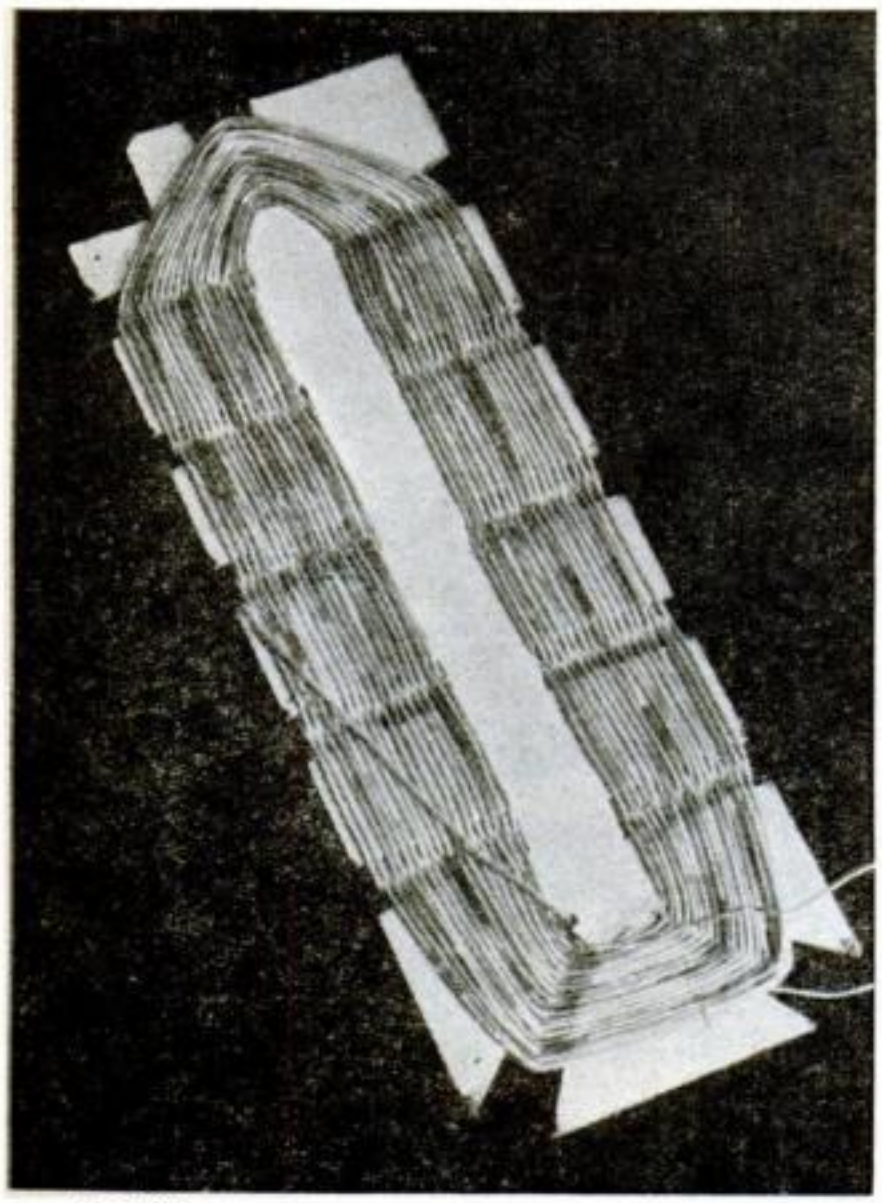
At left, the dial-cable assembly, showing the knob on the condenser shaft and the built-up bushing on the dial hub. Above, note the angle brackets atop the I. F. transformers for fastening to the case.

imized by breaking the 115-volt line at the B-minus side of the switch. This side is directly connected to the audio return circuit, where little hum voltage exists.

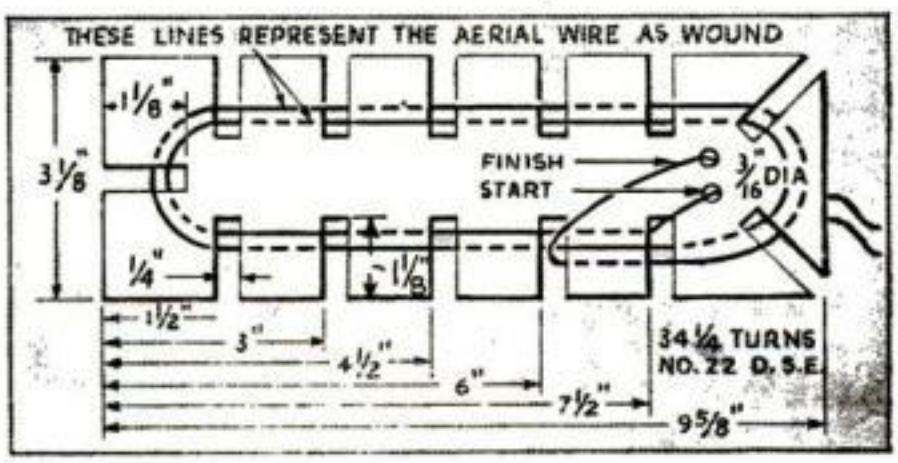
Alignment and adjustment of the set follow the usual procedure. If a signal generator is available, trace the signal through the I. F. transformers, and adjust for maximum output. Without a generator, the adjustment can be made on the air. Intermediate-frequency transformers are generally tested at the factory and set approximately to operating frequency. It is only necessary for you to compensate for the difference between the manufacturer's test equipment and your circuit by tuning in a strong local station (which should come through the factory-set transformers) and adjusting for maximum strength.

If a high-resistance voltmeter is handy, clip it directly across the outside terminals of the volume control. Use a meter scale that includes at least .5 megohm (on a 1,000-ohms-per-volt instrument, this would be the 500-volt scale) and align the I. F. trimmers for maximum voltage.

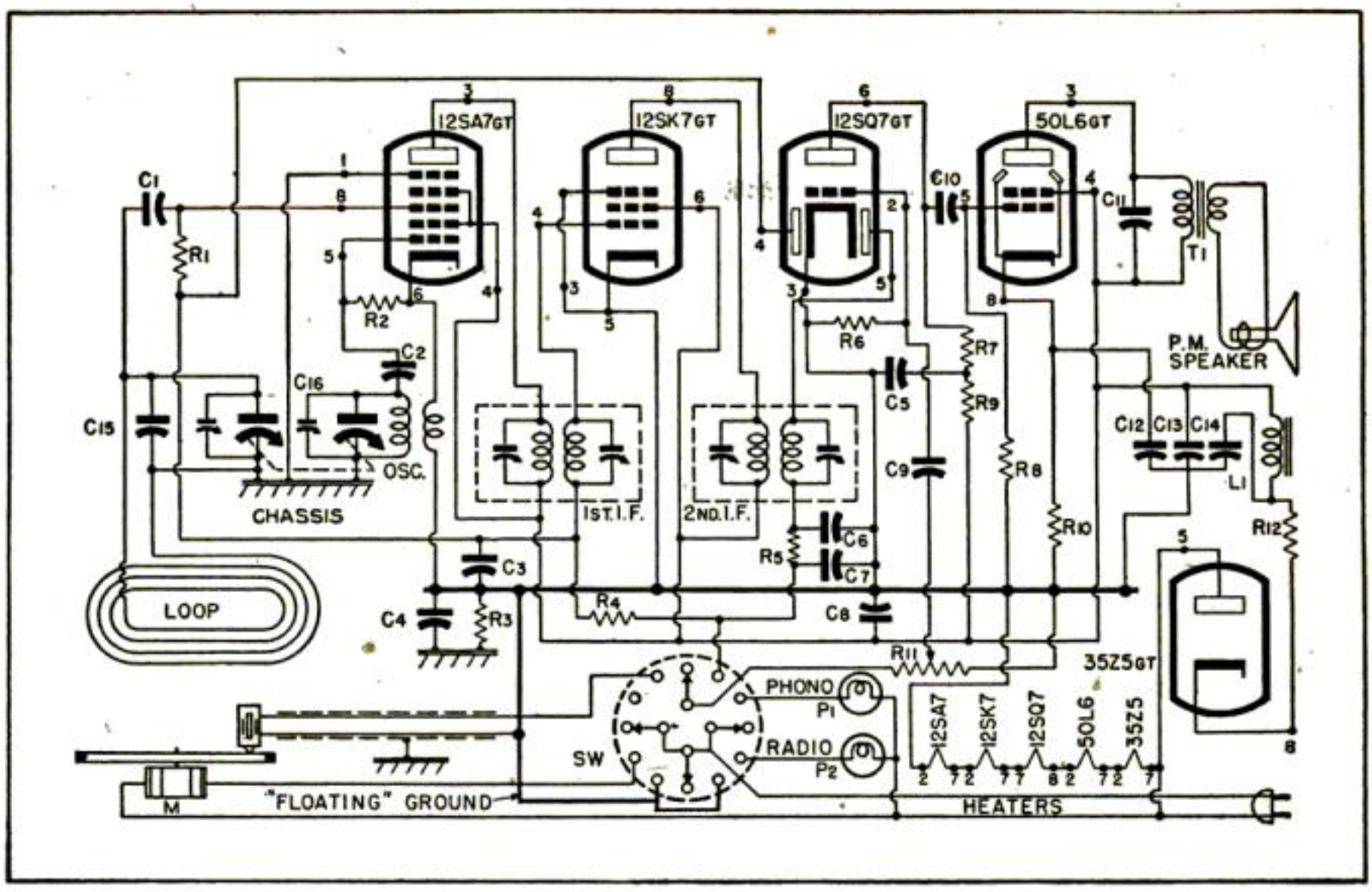
On the oscillator section of the gang con-



If it is necessary to alter the dimensions of the antenna, try to maintain the proportions as shown.



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denser, C 16, the trimmer should be set to about one full turn out from the "tight" position. It may be necessary to alter this setting later if the frequency coverage of the receiver is incorrect, but use this as a starter. Tune the set to a station near the high end of the band (i.e., with the condenser almost fully open), and adjust the trimmer on the antenna section of the condenser for greatest signal volume. If the peak volume is not passed by the time the trimmer is fully tightened, add a 10-mmf. or 20-mmf. mica condenser (C 15) across the gang-condenser section. Use whichever value is needed to peak the trimmer.

Now tune in a station at the low end of the dial, and see if the signal strength can be improved by altering the setting of the trimmer. If more capacity—tightening of the trimmer—is needed, add about a half turn to the antenna loop, and repeat the tuning procedure, starting at the high end. Continue adding wire, a half turn at a time, until no trimmer change is needed at the low end of the dial. The set is then properly tracked. If less capacity is needed on the first trial at the low end, remove a half loop of the antenna and continue removing turns until tracking is right.

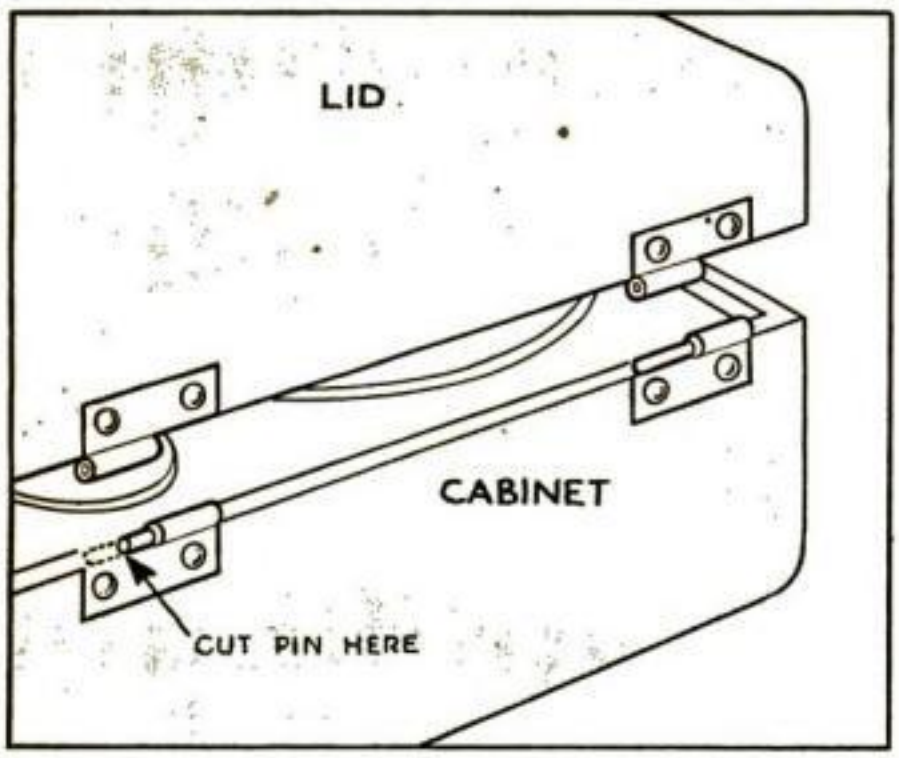
The set is held in the cabinet by two L-brackets placed under the hold-down nuts on top of the I. F. transformers, and by screws connecting the panels and cabinet.

LIST OF PARTS

C1, C2: 50 mmf. mica.
C3: .05 mfd., 250 volts.
C4, C5, C8: .25 mfd., 250 volts.
C6, C7: 100 mmf. mica.
C9: .002 mfd., 250 volts.
C10: .02 mfd., 250 volts.
C11: .01 mfd., 450 volts.
C12, C13, C14: triple-capacity electrolytic. C12, 20 mfd. 25 volts; C13, C14, 20 mfd. 150 volts.
C15: 10 or 20 mfd. See text.
C16: Two-gang tuning condenser with trimmers.
R1, R8: 1 meg.
R2: 35,000 ohms.
R3: 250,000 ohms.
R4: 2 meg.
R5: 50,000 ohms.
R6: 10 to 20 meg.
R7, R9: 500,000 ohms.
R10: 170 ohms, ½ watt.
R11: 500,000-ohm pot.
R12: 25 ohms, ½ watt.
(Resistors ¼ watt unless otherwise specified.)
T1: Output transformer.
L1: Filter choke.
Osc.: Oscillator coil.
Sw: 4-pole, 3-position rotary switch.
P1, P2: 115-volt pilot lights.
M: Phonograph motor.
Permanent-magnet speaker, 2 intermediate-frequency transformers, crystal pickup, tubes, sockets, knobs, dial, misc. accessories.

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Short Pin Improves Lid Hinge



For easier replacement of the detachable lids on some portable radios, phonographs, and typewriters, cut about ⅛" off one of the hinge pins. Then both pins need not be lined up simultaneously. To attach the lid, engage the longer hinge pin first, sliding it into the hole far enough to serve as a pivot while the shortened pin is being aligned with its hole.—W. E. B.

Fiber Tool Adjusts Condensers

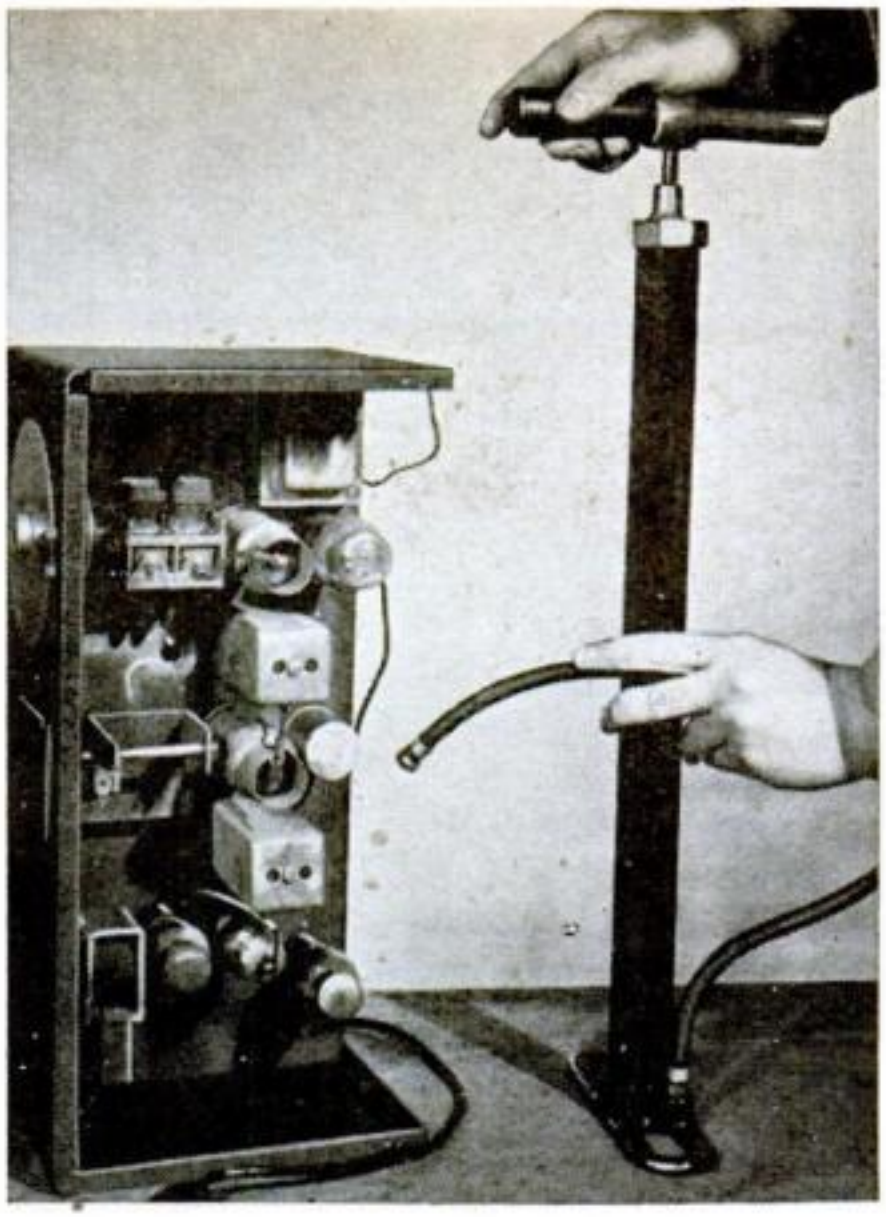


FIBER SCREW DRIVER

Blown tubes and painful jolts often result from the careless use of metal screwdrivers in adjusting trimmer condensers. For safety, and to eliminate the adjustment errors that arise from capacity effects, cut a tool from ⅛" fiber or other stiff insulating material. File the blade to screwdriver shape.—A. M. Lindner, jr.

Oil Solution Cleans Crackle

Dust-collecting crackle finishes used on radio equipment can be cleaned with carbon tetrachloride and a few drops of oil. About 10 drops of household oil to one ounce of the tetrachloride will prevent the surfaces from drying a lusterless gray. Apply with absorbent cotton and wipe with a soft cloth.—G. F. Bates.

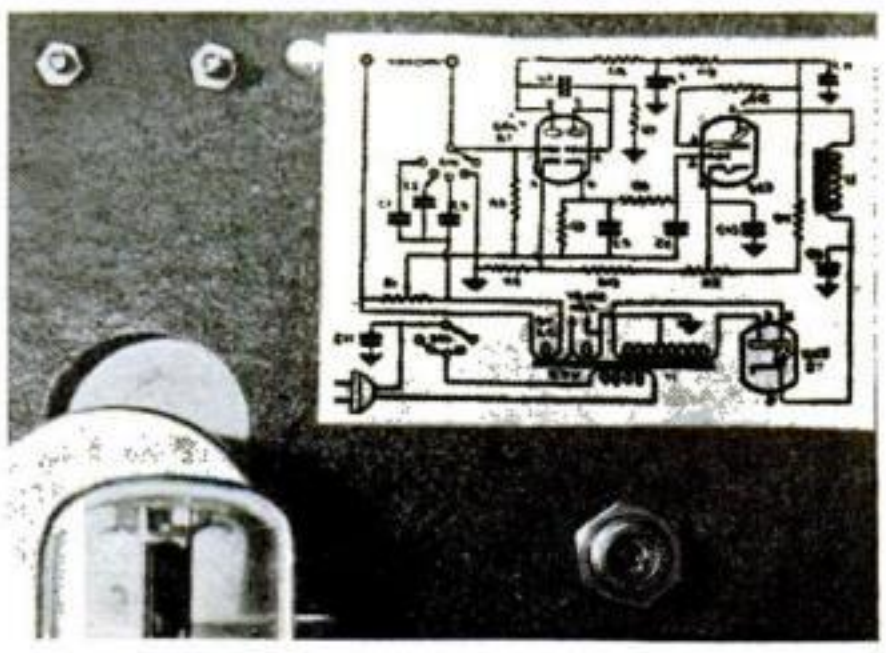


Tire Pump Dusts Radio Chassis

An automobile tire pump cleans radio chassis effectively. Tubes, shields, condenser plates, and other often inaccessible parts that require occasional dusting can be reached by the air stream from the flexible pump hose.

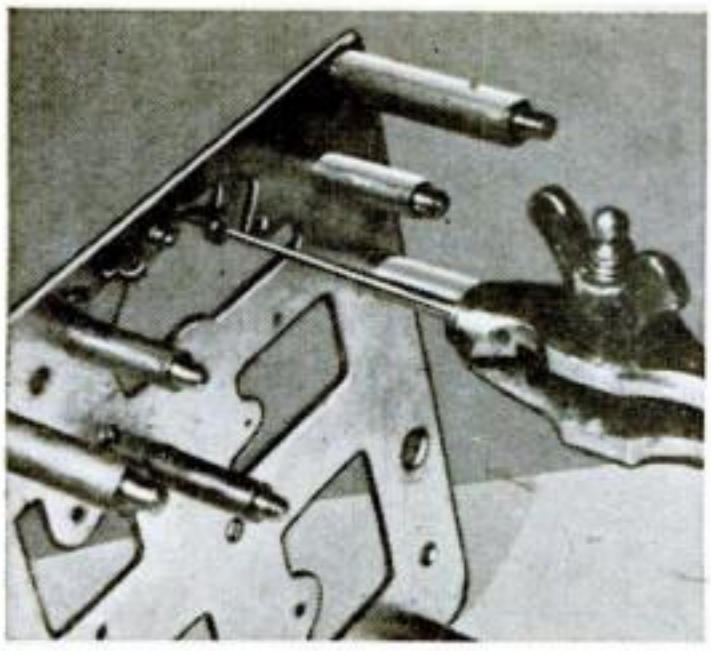
Diagram on Set Speeds Repairs

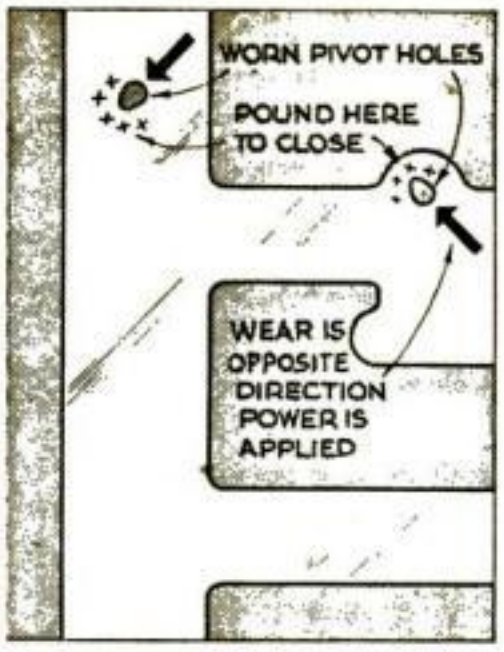
Future repairs on homemade electronic equipment will be made more intelligently and quickly if the circuit diagram is cut out and glued to the chassis or panel when the wiring is done. Water glass or household cement will hold it on crackle-finish panels.

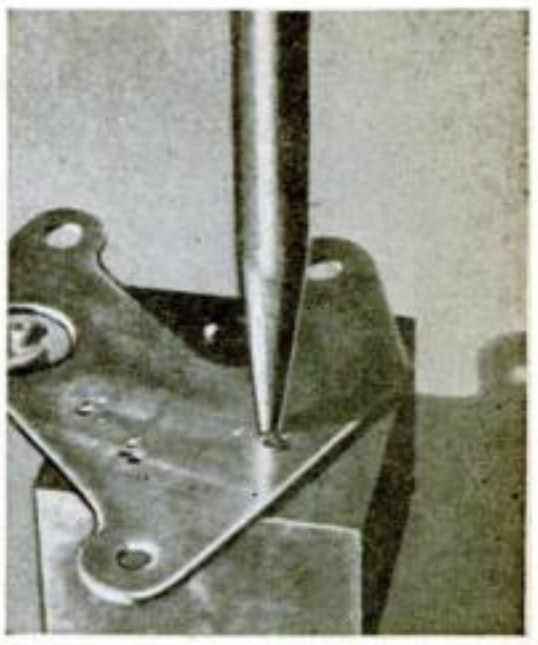


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Punch and Broach Used to Correct Worn Pivot Holes in Clock

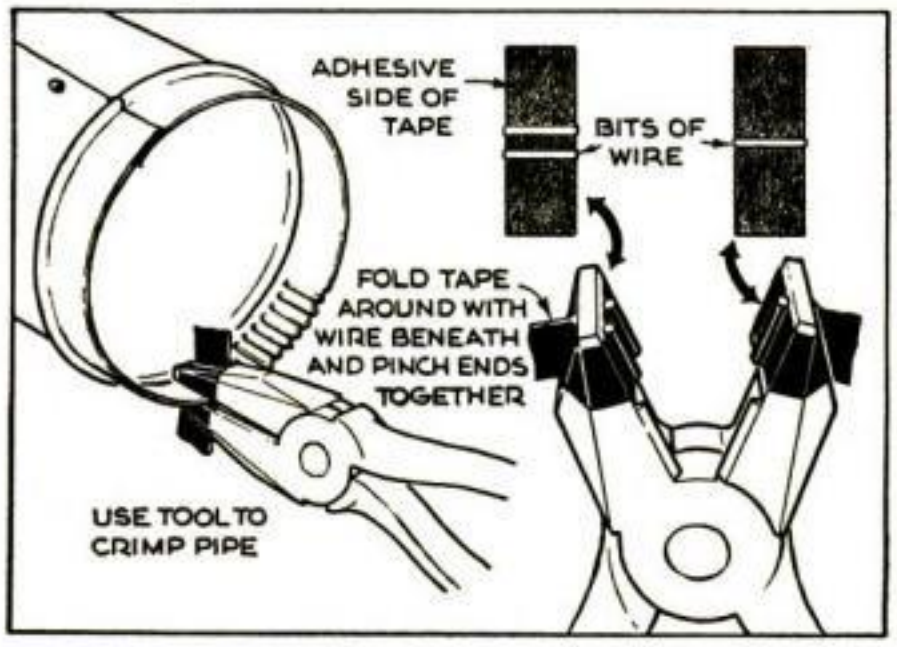






If your clock has stopped because the pivot holes are worn out of round enough to disturb the gear meshing, you can start it ticking regularly again by punching the holes almost closed and then broaching to size.

Disassemble the clock, noting which arbor fits in each hole. Since the holes wear on the sides away from the driving gear, close in these sides by pounding the inside on an anvil with a round-faced punch. The resulting holes will be too small for the pivots, and must be opened with a round broach. The pivots should then fit freely, permitting each wheel to spin easily. To make a round broach, file a long, true taper on a piece of drill rod, bring it to red heat, and quench. Then polish and slowly heat until it is straw-colored, turns purple, and finally becomes blue.—William Schopp.

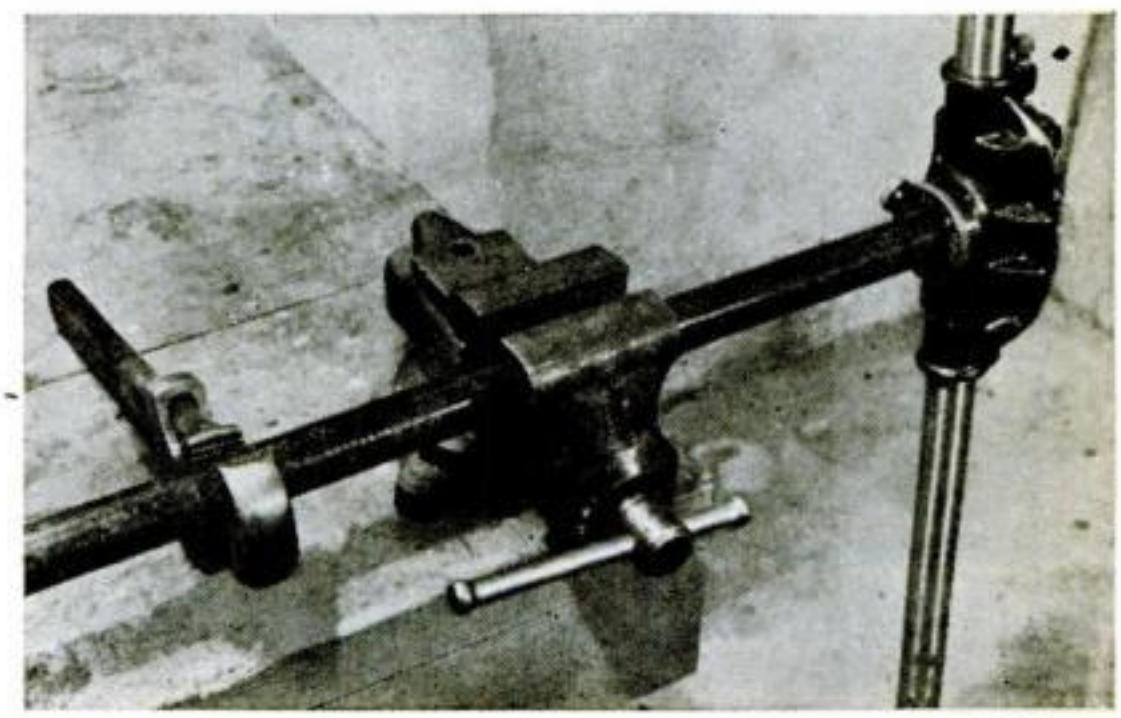


Pliers Serve as Crimping Tool

Save your fingers when coupling stovepipe or light-gauge ducts by using this homemade tool. Capable of crimping sheet metal as thick as .064", it can be improvised from a pair of ordinary mechanics' pliers, a few finishing brads, and adhesive tape. Cut the brads—wire would serve as well—into ½" lengths and stick them to a strip of the tape as shown in the sketch at the left. Then wrap the tape and cut brads around the jaws of the pliers.—William C. Furman.

Wrench Clamps Piping When Threads Are Cut

To prevent a length of pipe from twisting in the vise jaws while threads are being cut, clamp it with a large wrench as shown in the photograph at the right. The vise holds the pipe as usual, but the wrench handle, resting against the top of the work bench, immediately stops any tendency of the pipe to turn during threading.—W. T.



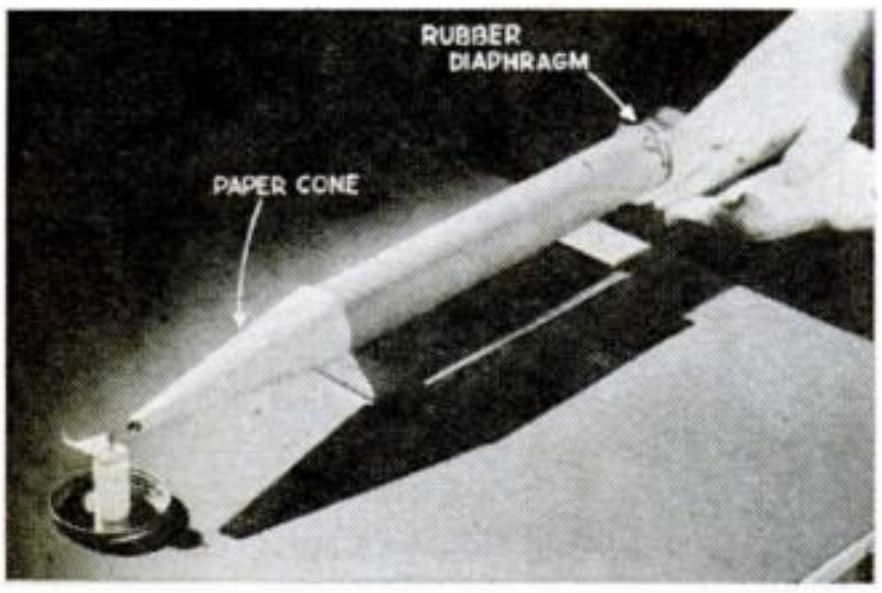
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HOME EXPERIMENTS

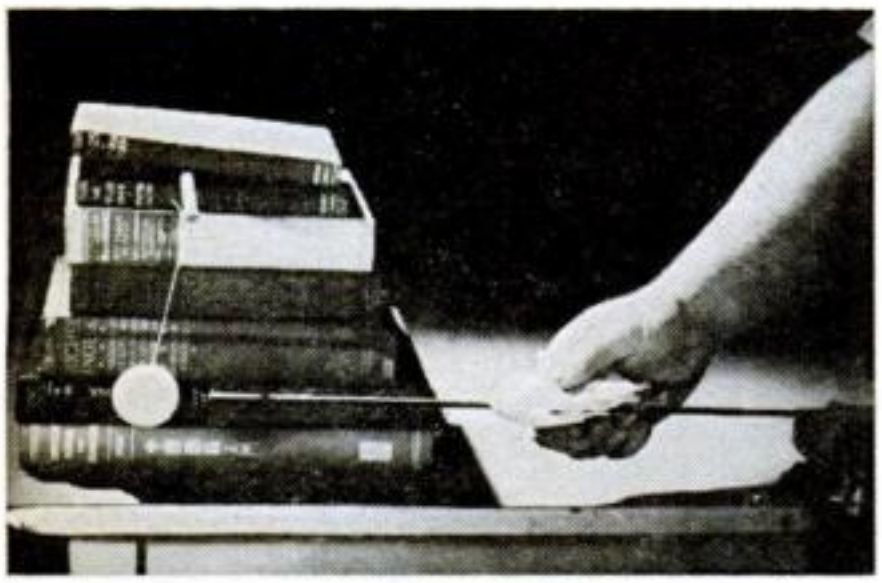
SOUND . . . Air in Rhythmic Motion

SOUND WAVES cancel each other when a crest is superimposed upon a trough. Conversely, when the crests overlap, the sound is increased. To demonstrate this, strike a dinner fork on a table, hold it vertically near your ear, and rotate it slowly. At one point, the sound becomes almost inaudible. Continue rotating, and it grows louder.





AIR MOVEMENTS are produced by sound waves, as can be shown with the setup at the left. Make a paper cone with an opening about ¼" in diameter at its small end and fasten this to a mailing tube about 24" long. Over the other end stretch a diaphragm cut from a toy balloon. Then light a candle and support the tube so the end of the cone is near the flame. Now clap your hands close to the diaphragm. Sound waves will cause it to vibrate, creating air waves in the tube that blow the flame.



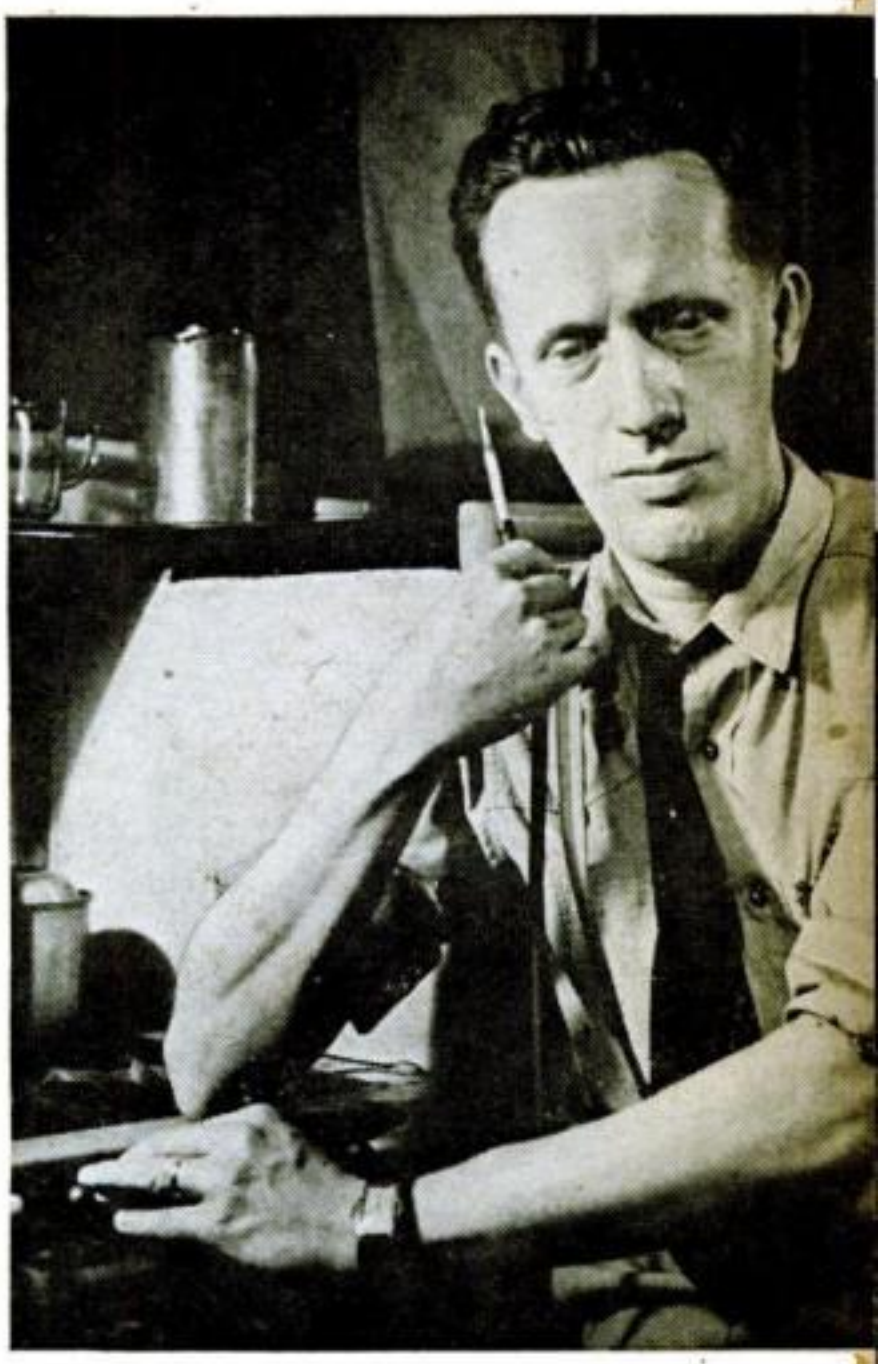
LONGITUDINAL VIBRATIONS can occur in a metal rod under certain conditions. Clamp one end of a solid curtain rod in a vise, and suspend a table-tennis ball from a string so its middle just touches the other end of the rod. Now rub along the rod firmly with a piece of cloth or leather dusted with rosin. A definite note will be given off, and the ball will fly outward, as above, because of the longitudinal vibrations.

YOUR HEAD BONES help you hear sounds. You can demonstrate this by striking the tines of a dinner fork on the table and touching the handle firmly to the bone directly behind your ear. Repeat, touching other bones in the head. You will find that the relative loudness depends largely upon the amount of insulating flesh covering the bone. For the loudest result, separate your lips and clamp the handle in your teeth.



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SOUND PRODUCED in a gas lighter than air in an enclosed space is higher in pitch than if air were the medium, for sound travels faster in such a gas than in air. For this experiment, remove the bulb from a medicine dropper, connect the dropper to your illuminating-gas supply, hold the dropper to your ear, and turn on the gas. For a moment the pitch of the rushing stream will be low. Then suddenly it will become higher. The reason? Air being swept from the tube causes the low pitch, and gas the higher.





TRANSMISSION of sound varies considerably with the material. You can show this by striking a fork on a table and then placing the end of the handle firmly on a wooden dowel, the other end of which touches the table. The table will respond with a loud vibration. Now substitute materials like metal, rubber, and cork for the dowel, noting the difference the rubber and cork make. Such materials are sound deadeners.

LISTENING TO THE WIND is easier with the device in the drawing below. Hold the end of the rubber tube to one ear and the nozzle in front of an electric fan. As the breeze passes the wire, eddy currents are set up and the ordinarily inaudible air currents are converted to a sound you can hear.

ENCLOSED AIR COLUMNS give off characteristic sounds when excited by air vibrations. To show this, use the same device as at the left, this time blowing through it across the mouth of a milk bottle. You may improve results by varying the blowing and the distance of the wire from the nozzle.





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Electric-Arc Torch

By FRANK ROWSOME, Jr.

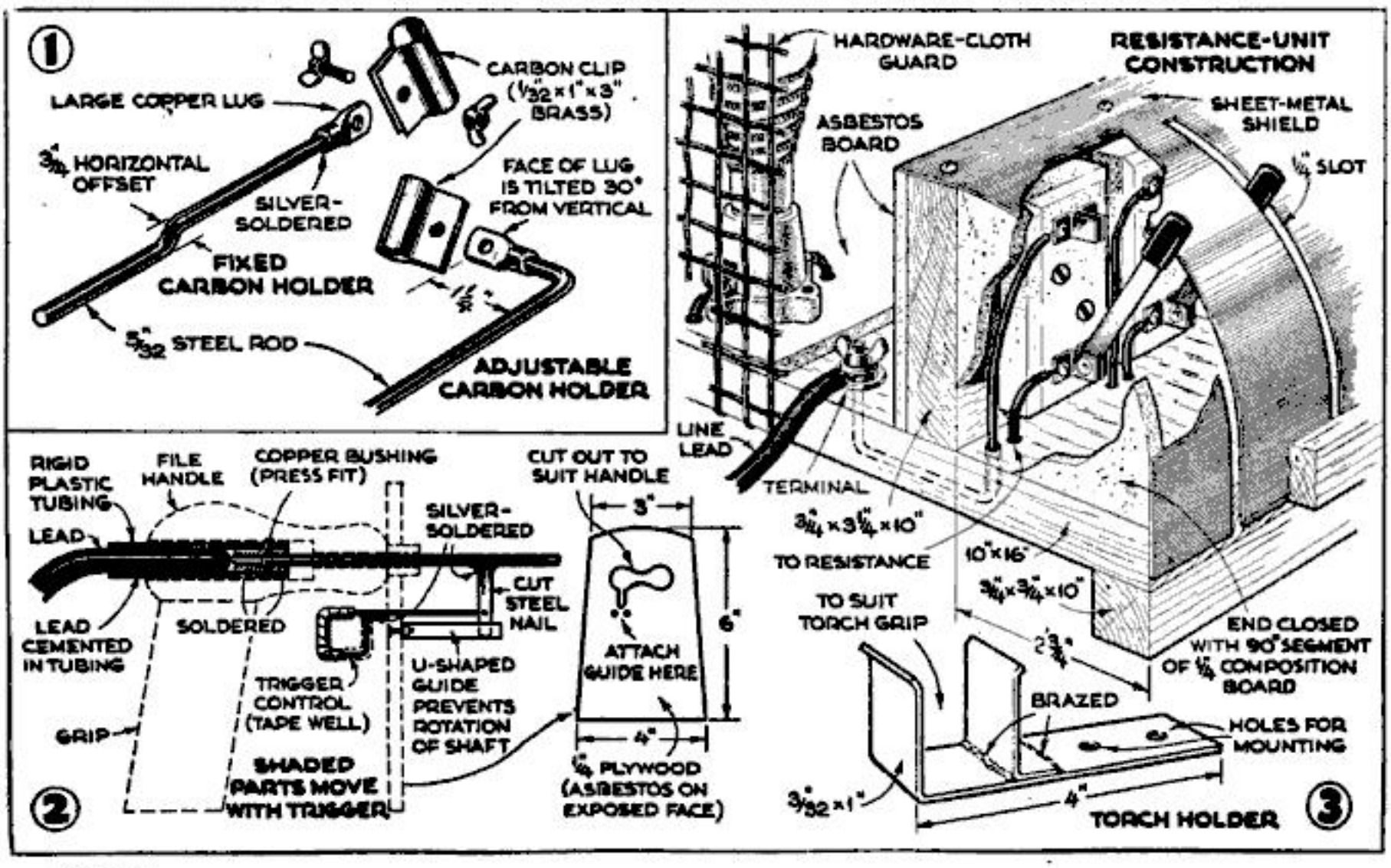
BEING able to braze adds immensely to the working scope of the home craftsman. If you have been limited to soft solder, screws, and rivets as means for holding stressed metal parts together, the opportunity to supplant these methods with brazing—not much behind welding in strength—will open new vistas for your home-shop projects.

Brazing itself isn't difficult—no more so in its own way than soldering. The problem is to get enough heat and to get it in the right places. While it is possible to braze small objects with a blowtorch, or even on a kitchen gas burner, these methods seriously limit the size of the work. The electric-arc torch described here not only generates ample heat for brazing good-sized metal parts, but it also possesses finger-tip control, simplicity of adjustment, and an adaptability for use in tight spots. It can be built in a few evenings' time, costs little to make, and, if properly designed, does not draw excessive line current.

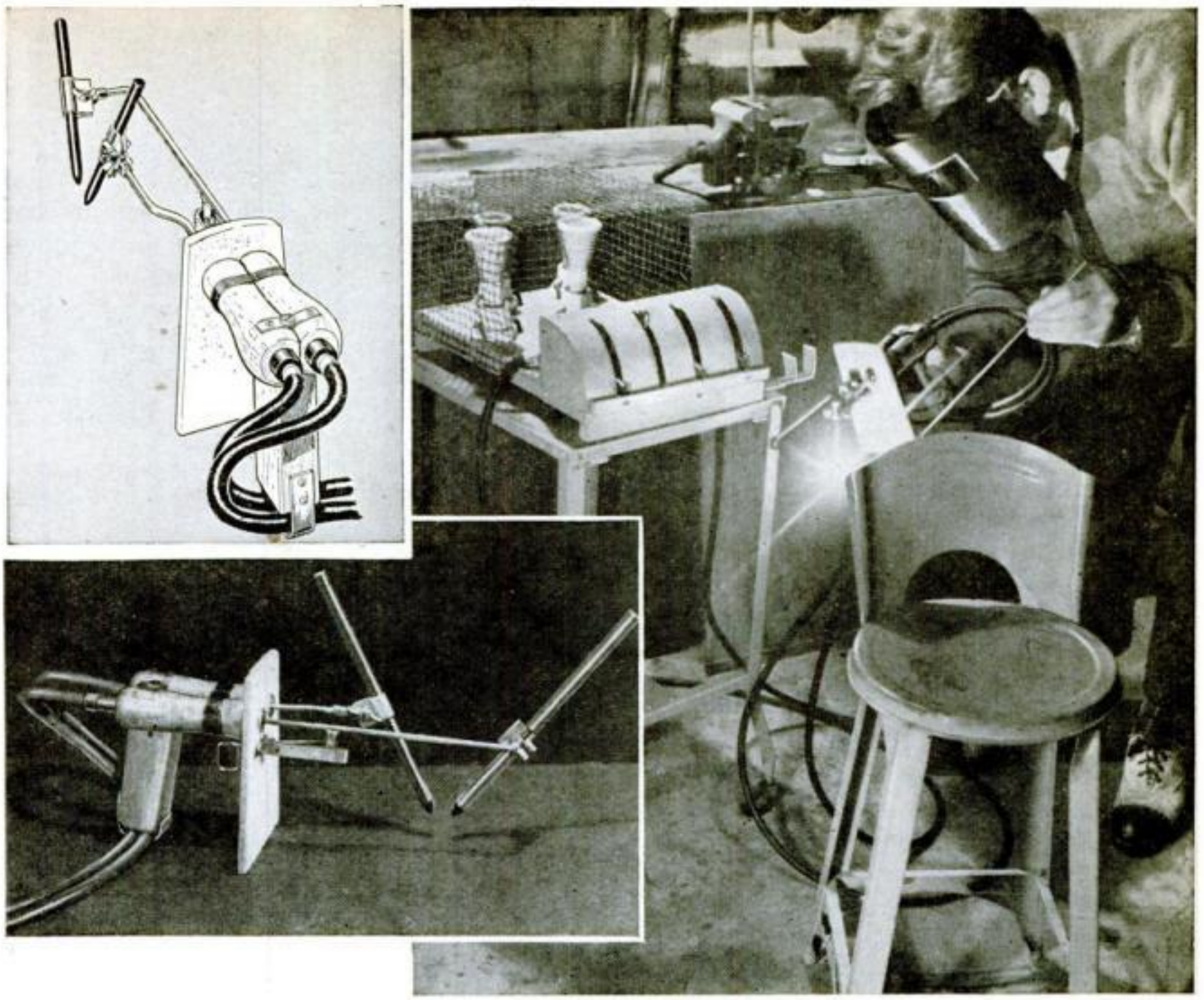
The principle of the twin-carbon arc torch is extremely simple. Two carbons are connected across the power line and momentarily touched together. The immensely hot arc that results is then played over the work, much like the flame of a torch. A variable resistance in series with the carbons limits current draw; by switching in more or less resistance, you can control the effective heat.

As shown in the accompanying photos, the device consists of two separate pieces of equipment: a pistol-grip carbon holder, and a resistance unit with suitable control switches. For shop convenience, the latter is mounted on a steel typewriter table.

Obtain a pair of file handles 4″ or 5″ long, and plane a flat on the widest portion of each so that they fit together lengthwise. Drive several short brads into one of the flats, sharpen the heads, and press on the other flat. Reinforce the joint with glue and a tight lashing of wire. A thin metal plate is also screwed on across the top of the handles at their widest point. After assembly, plane another flat on the bottom of the pair for the pistol grip, which is a 1¼″ by 1½″ by 3¾″ hardwood block. The grip is attached by means of a long wood screw driven down



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In addition to silver-soldering and brazing, the torch can also be used for light welding; burn-cutting sheet metal; preheating; hardening, tempering, and annealing tool steel; and heating stock for bending or forging. Never look at the bright flame of the arc without the protection of welding goggles or a mask.

through a hole in the metal plate on top.

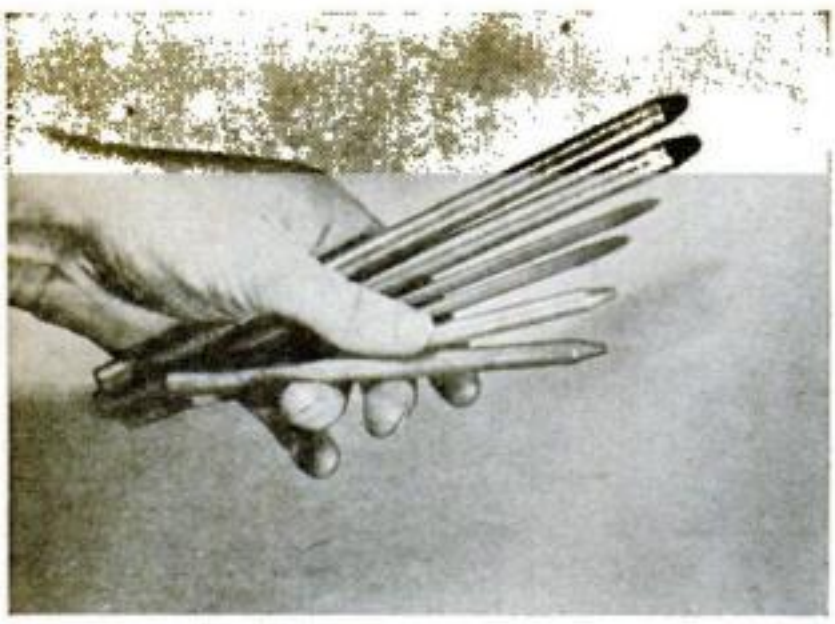
Each file handle receives a steel rod 5/32" in diameter that acts as an electrode holder. The left-hand rod (looking at it from behind the handle) is fixed in its socket and supports the inner carbon. The other is free to slide in its handle, permitting the outer carbon to be positioned by the trigger control. If left-handed, you may find it more convenient to reverse this relationship.

To prevent the movable rod from rotating and misaligning the carbon, the construction shown in Fig. 2 is used. A cut steel nail, sawed to a length of 1½" and drilled with a ⅛" hole in the middle, is silver-soldered to the rod. Don't use soft solder since the heat of the arc would loosen it. The lower end of the cut nail slides in a U-shaped bracket that extends 2¾" from the shield and keeps the rod from turning. A length of coat-hanger wire, one end formed in a finger loop and the other passed through the hole in the nail and peened, controls the position of the rod and carbon. Although this will be the grounded carbon, wrap the trigger well with insulating tape as an additional protection against shock.

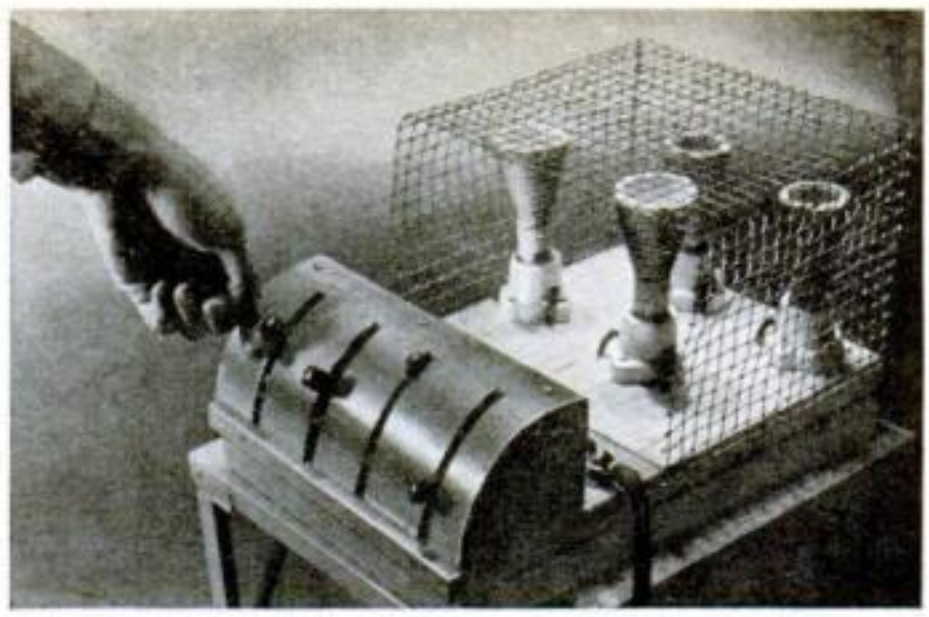
To align the carbons in the same longitudinal plane, the fixed rod is bent in a ¾" offset to the left, and the movable rod is bent 90 deg. 1¼" from its end. The carbons themselves are secured to the rods by brass clips that are clamped to large copper lugs by thumb screws and wing nuts, as shown in Fig. 1. The lugs should be silver-soldered to their rods. Attach the outer lug at an angle of about 30 deg. with the vertical, and the inner one fully vertical. The working angle of the carbons, normally about 60 deg., may be decreased for working in tight corners by adjusting the angle of the fixed-rod carbon clip.

While the connections within the handle are not complicated, some difficulty may be experienced in the assembly unless the correct sequence is followed. *[Turn the page.]*

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Use carbons from 3/16" to ½" dia. The cored type produces a stable, long, hot-tail flame.



Cover the switches with a slotted sheet-metal guard cut so that it cannot touch the bare switch blades.

1. Drill both handles longitudinally to a diameter that will be a press fit for the rods. Open out the right handle to an easy sliding fit.

2. Counterbore the back of each handle to a depth of 2". For the left one, use a bit that will afford a press fit for a plastic or hard-rubber sleeve; a sliding fit is required for the right sleeve. Both sleeves should fit snugly over the wire from the resistance unit.

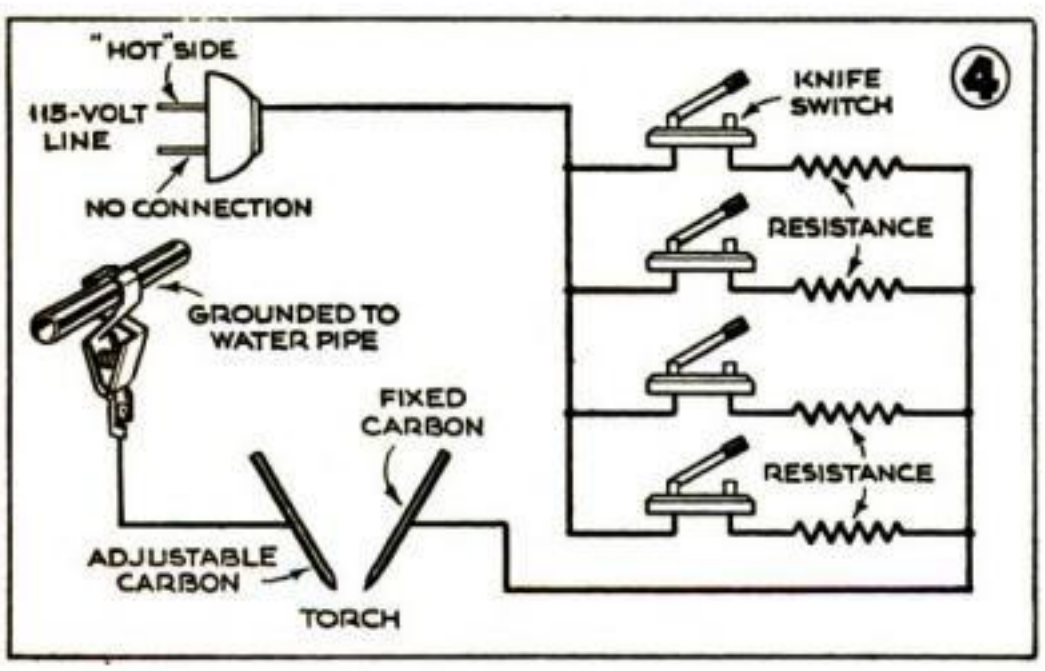
3. Cut and fit a shield shaped as in Fig. 2. This may either be of thin sheet metal or of ¼" plywood faced with sheet asbestos. If the holes through which the file-handle ferrules pass are drilled slightly undersize, the shield will be held firmly when driven up against the shoulders of the wood.

4. Silver-solder the lug to the left rod but do not form the offset. Force the other end well through the handle, and press the sleeve on the wire. Bare a little of the insulation, and soft-solder the wire to the rod, using a short piece of copper tubing over the joint as a reinforcement.

5. Apply quick-drying cement to the sleeve and the wire, pull the sleeve over the joint, and force the wire, sleeve, and rod into the handle. The offset in the rod may now be formed.

6. Follow a similar sequence with the right rod. Don't attach the cut nail until after the assembly, and take care not to get cement where it will interfere with the sliding action. Use a slightly longer sleeve than the one in the left handle.

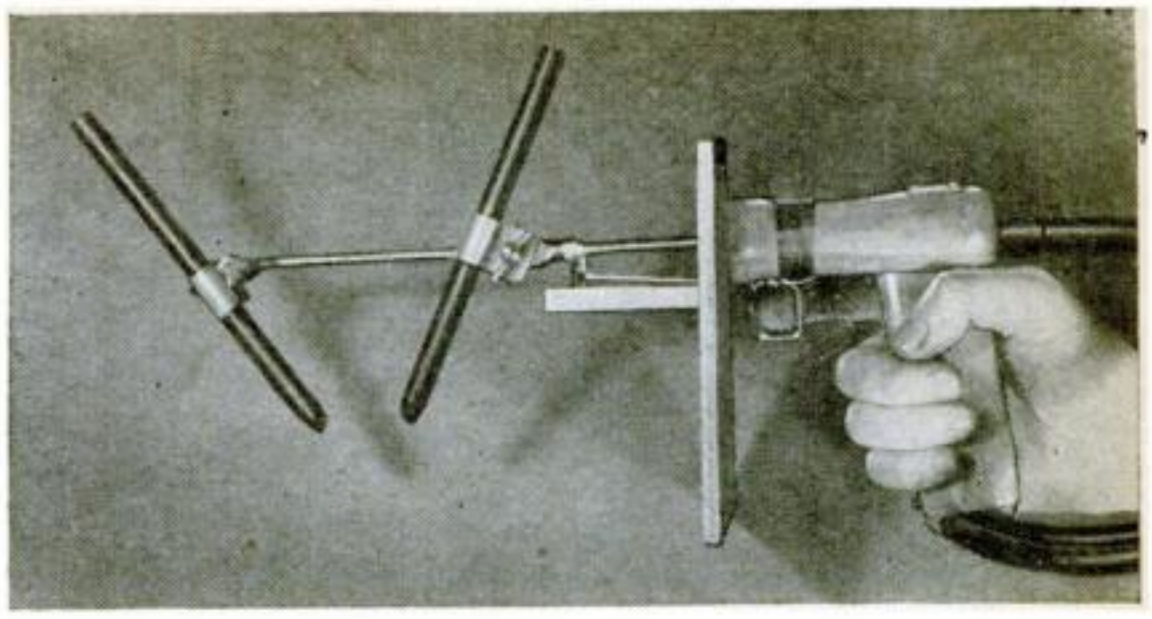
Use heavy wire, No. 12 or larger, in the torch and resistance unit. Single-conductor stranded wire with heavy rubber-covered insulation is ideal for the torch leads, which must be flexible. Connections within the resistance unit may be made with solid wire.





For the first brazing job with your new torch, make the holder shown in position at the right. Details are given in Fig. 3.

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Set the switches to give the desired heat, then pull gently back on the trigger until the carbons touch. When a slight spark signals that contact has been made, push the control slowly until the carbons are ⅜" to ½" apart.

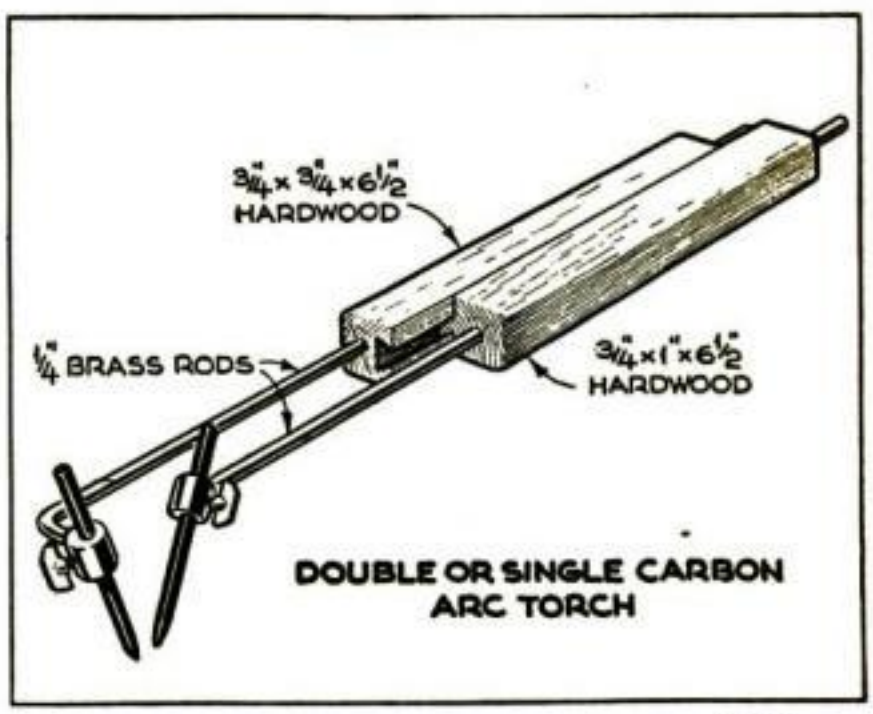
The design of the resistance unit depends upon the amount of current that may safely be drawn in your workshop. If only a branch circuit fused at 15 amp. is available, one 550-watt and one 1,000-watt heating element may be used as resistances. Depending on whether they are used individually or together, these will provide currents of 5, 9.1, and 14.1 amp. when cold. If your workshop is so situated that you may draw up to 30 amp. from a single separate circuit, use two heating elements of each wattage to get eight current steps: 5, 9.1, 10, 14.1, 18.2, 19.1, 23.2, and 28.2 amp. The lower values will generally be quite hot enough for many jobs; for most modelmaking or jewelry work, 10 amp. or less is ample; 15 amp. will permit you to braze, say, a ½" steel shaft; and 28 amp. is enough for repairing broken bicycle or lawnmower parts or similar heavy work. If no 30-amp. circuit is available inside the house, it may still be possible to install a line at the fuse box. This might consist of BX cable having both conductors connected to the hot side of the line at the box and terminating at a heavy-duty receptacle.

The construction of the resistance unit is suggested in Figs. 3 and 4, though actual details will depend on the number of heating elements selected. Surfaces of the unit exposed to heat should be protected by sheet asbestos board or a number of thicknesses of asbestos paper. As a protection against accidental burns, cover the heating-element resistors with a sturdy box frame made of hardware cloth.

Connect up the torch and resistance unit to the power line as shown in Fig. 4. The plug should be a heavy-duty type with the lead connected to just one prong, and the ground connection should be a large storage-battery clamp secured to a water pipe. Reverse the plug in the receptacle if an arc is not struck when the carbons are touched. One advantage of the ground-return circuit shown is the greatly reduced likelihood of any shock; it also keeps the heating effect on the house wiring to a minimum.

Light Brazing Torch Made from Dovetailed Hardwood Strips

QUICKLY assembled out of scrap material, this small carbon-arc torch consists of two hardwood strips of approximately the dimensions shown, with a sliding dovetail joint along the facing edges. The strips are drilled lengthwise to take two ¼" brass rods, and carbon holders are brazed to the ends of the rods. Make the holders out of any available brass scrap that can be drilled to the diameter of the carbons and tapped for wing-screw tighteners. Run some wax on the dovetail for easier action. You can also slide the sections apart and use one as a single-carbon soldering torch by grounding the work.—W. W. ANDERSON.



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The Microscope Looks at FIBERS



By J. R. JUNG

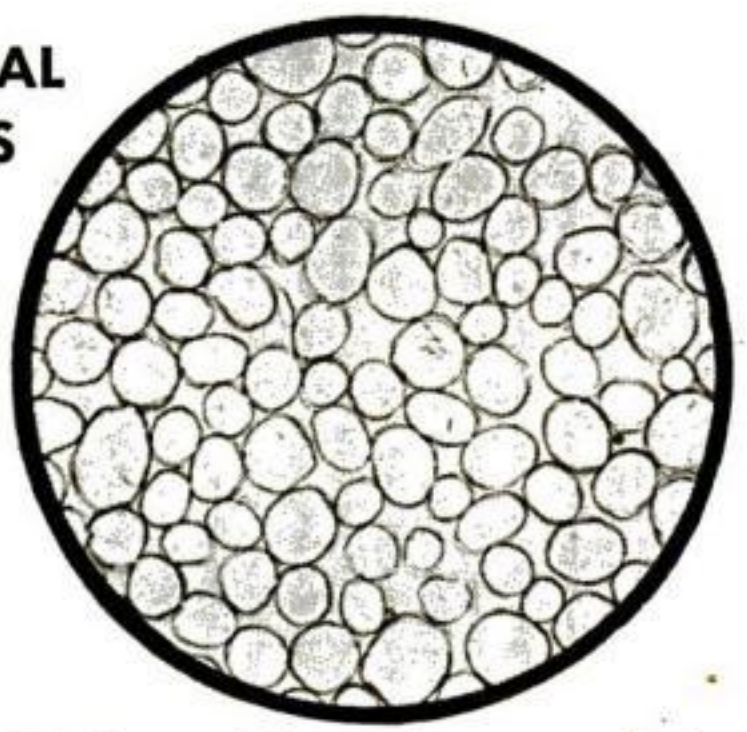
A WHITE shirt doesn't look much like the photograph at left below—but the difference is mainly in size. If you snipped a thread from a shirt, sliced an ultrathin cross section off its end, and put this slice under a microscope, you would get a view similar to the one shown.

Technologists in the textile industry do just that every day, not only to cotton for shirts, but also to nylon for stockings, wool

NATURAL FIBERS



COTTON, the most widely used of textile fibers, shows in this photomicrograph why it takes dyes so well—its cuticle is extremely thin, permitting easy absorption of the dye liquids. Note the small cross sections of young fibers.



WOOL has oval fibers with an unusually large lumen and practically no cell membrane. The cuticle is thin, enabling dyes to penetrate very deeply. The natural color of an unstained wool fiber like this would vary from white to tan.

HEMP is used in this country mainly for rope, since dyes are not easily absorbed through its thick cuticle. But this same characteristic gives toughness and weather resistance that add to its value for rope and special textiles.

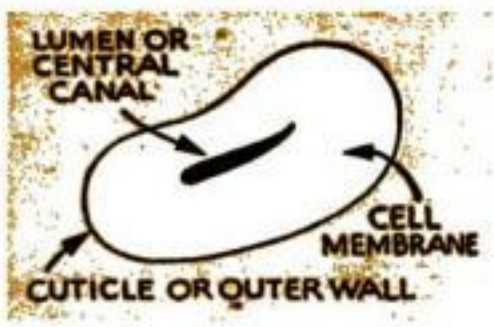


RAMIE, or China grass, is a plant fiber similar to flax. The cracks in the outer wall help it absorb dyes, but also make ramie cloth brittle and inelastic. A linen-like material used in the orient, it tears if folded frequently.



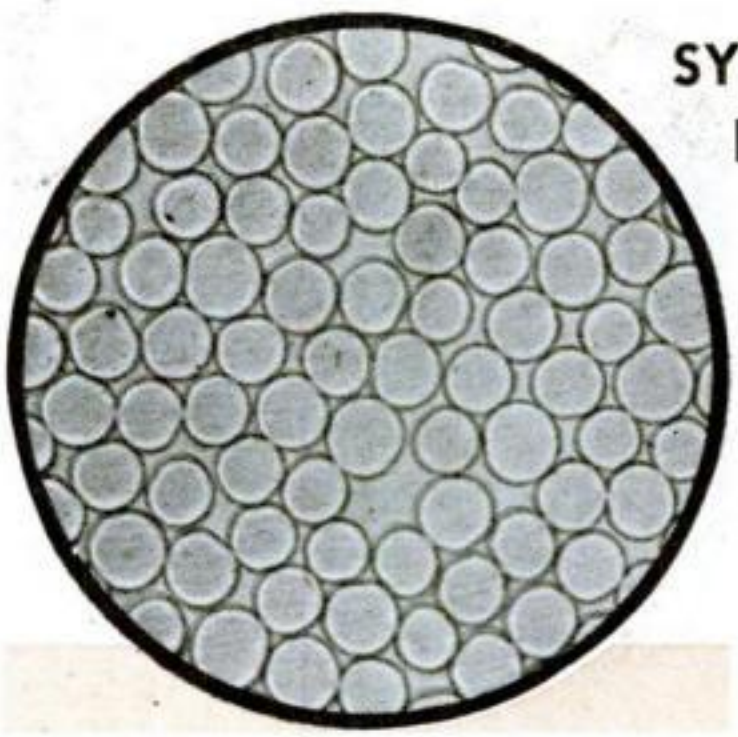
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for suits, or rayon for dresses. From this intimate peek at the inside of textile fibers, they can tell much about the quality of the fiber—whether it will resist laundering, form warm or cool clothing, dry quickly, or have other special characteristics of behavior or appearance.

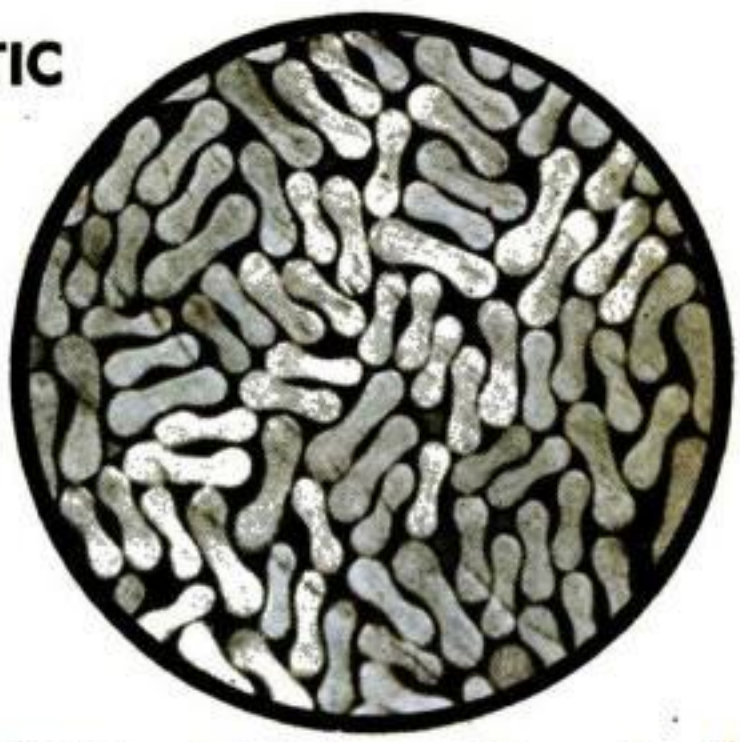


Microscopists divide textile fibers into two classes, natural and synthetic, differing in internal structure as well as origin. Unlike the synthetics, natural fibers have a well-defined interior arrangement. Variations in this internal structure—the size of the lumen and thickness of the cell membrane and cuticle—account for some of the differences in quality. Other natural-fiber characteristics can be traced to the shape and smoothness of the exterior surface. The surface factor applies also to synthetic fibers, which are further affected by their chemical composition. Because all these features are easily seen with the microscope, it has become one of the most important tools in textile research, making possible better and better fabrics for less and less money.

SYNTHETIC FIBERS



NYLON, the coal, air, and water fabric prized for sheer stockings, has round, smooth fibers. Resistant to laundering and dry-cleaning, and easily dyed, it dries with unusual speed. Some nylon fibers melt in boiling water, however.

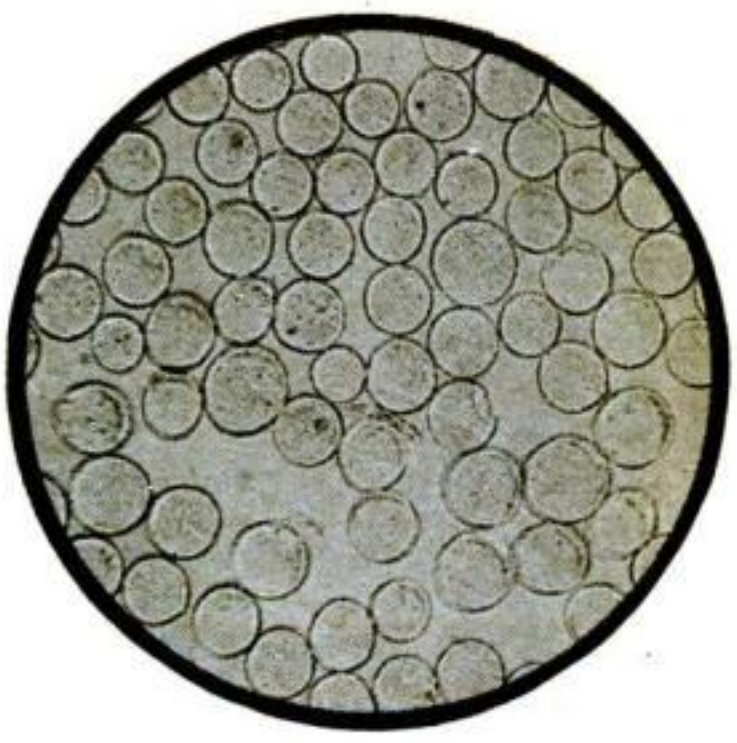


VINYON is extruded from a white powder dispersed in acetone, producing fibers with a corrugated exterior and a dumbbell-shaped cross section. Vinyon shrinks slightly in hot water, but is little affected by acids, bacteria, or fungi.

VISCOSE RAYON was the first synthetic fiber to see widespread use. Rivalling expensive silk in many qualities, it is made from humble wood pulp and costs little more than cotton. Rayon fibers 60 miles long have been produced.



ARALAC, one of the newest synthetics, is made from milk protein. The amazing similarity to wool fibers, obvious when photomicrographs of both are compared, results in aralac materials almost indistinguishable from fine woolens.

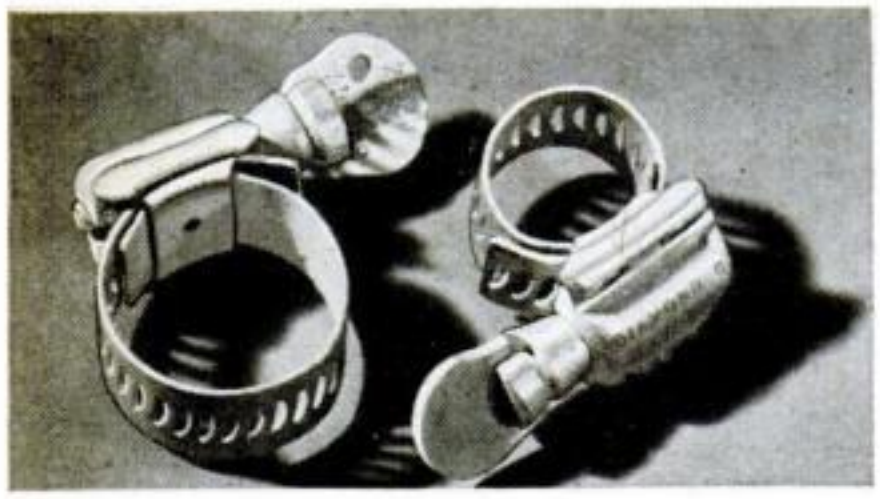


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Plane Clamps Are Handy in Lab

TUBING clamps operating on a new principle are now available for the chemical laboratory and home workshop. Designed originally for sealing rubber-hose connections in military airplanes, the clamps completely encircle the tubing and are tightened or loosened merely by turning a thumbscrew. This operates a worm gear meshing with perforations in a steel band.

Fisher Scientific Co., of Pittsburgh, and Eimer & Amend, of New York, distribute both this item and the mortar and pestle below.







New Mortar Is Extremely Hard

EVEN such hard abrasive materials as emery and carborundum are easily pulverized with a new mortar and pestle made of boron carbide, the hardest material ever produced by man on a commercial scale. Because boron carbide does not wear off and contaminate samples, the new equipment is especially useful when highly accurate analyses must be made. A stainless steel casing is shrunk into place around the bowl.

ACID TEST



Each line of the rhyme below describes an acid listed at right. See if you can put the number of each beside the acid described.

1. This acid gives storage batteries power,
2. This one's contained in milk turned sour.
3. Hhere's one the glands of your stomach produce,
4. And this is in orange and lemon juice.
5. A solution of this makes a bath for the eyes;
6. This'll take ink spots out of white ties.
7. Now this one is used as a food appetizer;
8. The next one's an excellent sterilizer.
9. In processing leather this acid is needed;
10. As true aqua fortis this is conceded.

—*Frank Shore.*

.....Hydrochloric.
.....Citric.
.....Sulphuric.
.....Carbolic.
.....Tannic.
.....Boric.
.....Nitric.
.....Lactic.
.....Oxalic.
.....Acetic.

ANSWERS

1. Sulphuric. 6. Oxalic.
2. Lactic. 7. Acetic.
3. Hydrochloric. 8. Carbolic.
4. Citric. 9. Tannic.
5. Boric. 10. Nitric.

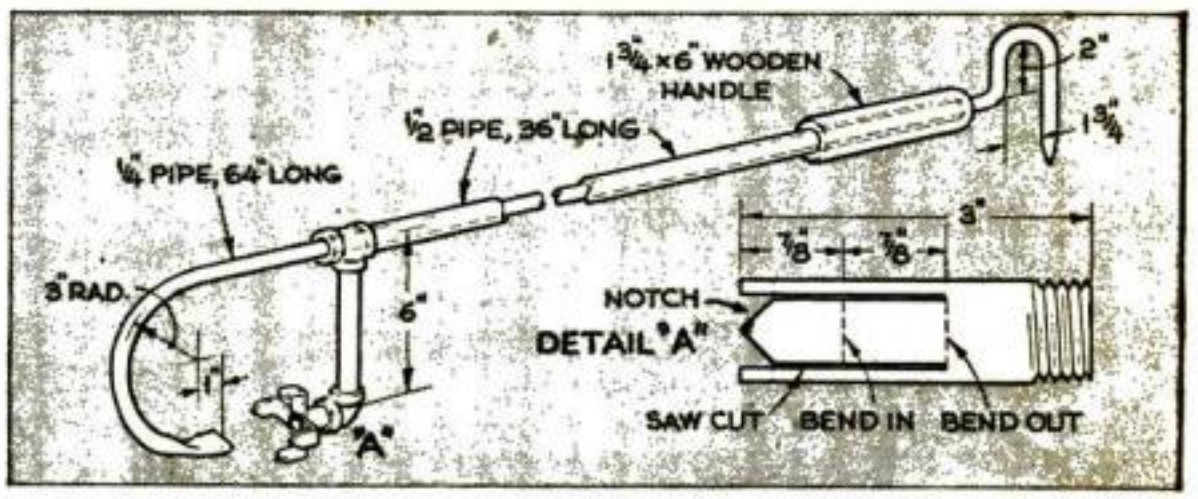
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Homemade Tongs, Built of Pipe, Pick Clinkers from Furnace



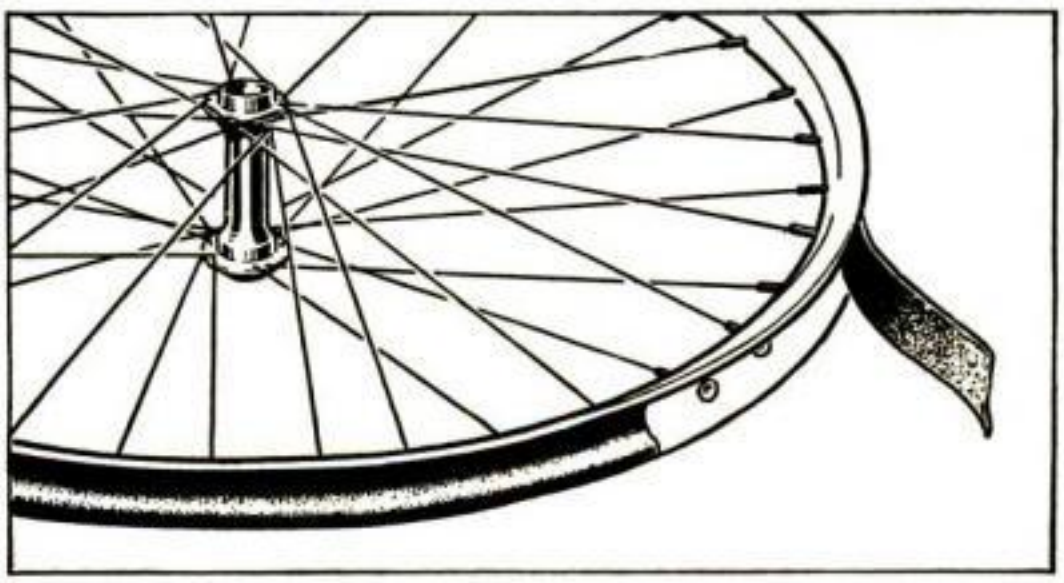
TONGS for quick removal of clinkers can be made from a few feet of pipe. Bend a handle on a 64" length of ¼" pipe. Then slip over it the sliding part, a 36" length of ½" pipe with a tee connection at one end and at the other end a drive-fitting wooden handle 6" long and 1¾" in diameter. Next bend the 3" hook.

Make the claw from a 3" piece of ½" pipe threaded on one end. Hacksaw four evenly-spaced slots in the unthreaded end, and point the resulting segments. These prongs are flattened by hammering against a square rod inside the pipe. Then make two right angle bends in each prong. Screw the claw into an elbow and assemble on the sliding pipe with a 4½" nipple.—O. D. COWLES.



Inner Tubes Make Bicycle Rim Tapes

IF NEW tapes for bicycle rims are not available, replacements can be improvised from old bicycle inner tubes. Cut a strip between ⅜" and ¾" wide, making it long enough to stretch snugly around the rim without too much tension. Several inches of overlap at the ends should be allowed. Punching the valve stem hole in the center of this overlap will make the hole stronger and less likely to cause a rip. Then cement the lapping ends together. When the cement has dried, the tape can be stretched into place over the rim.—R. S. MACNEILL.



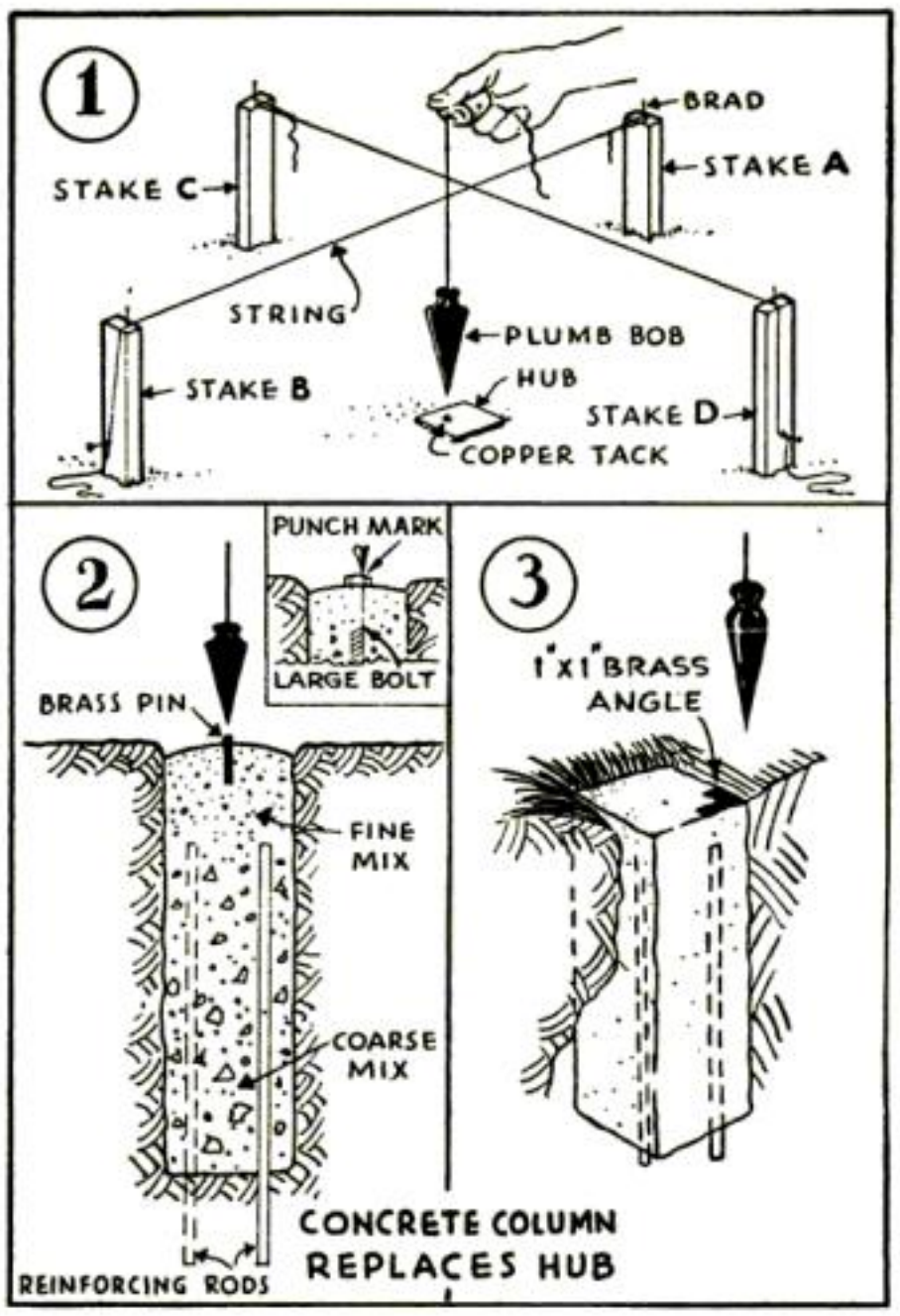


Knob Helps Cut Glass

GLASS cutting can be made easier on the hands by slipping a knob, such as a drawer pull, over the end of the cutter handle. The use of the knob also makes it easier to apply the correct pressure.—KENNETH MURRAY.

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Permanent MARKERS

for

Your Property Lines

SURVEYORS generally leave markers consisting of wooden "hubs" or stakes driven in the ground, each with a copper tack in the end to locate an exact point, and with a marker stake nearby. Few property owners make any effort to preserve these established points, which in time are almost inevitably lost or damaged.

For future occasions when you may wish to erect a fence, plant a hedge, or build a road, permanent concrete columns or "monuments" extending from 1″ to several feet above the ground are extremely useful. If your local and State laws do not forbid, you can put in these monuments yourself, or it may be possible to install them under the supervision of a licensed surveyor. It is best to check also with the owner of the adjacent property and to have him help or watch over the work.

One straighforward method of relocating the surveyor's exact mark without the expense of a new survey is shown in Fig. 1. Drive a nail or brad in the ends of stakes *A* and *C* and another nail or brad down somewhat in the broad side of stakes *B* and *D*. The stakes should be 1″ by 2″ stock at least 24″ long—longer if the ground is very soft or rough, for they must be kept rigidly in place until the work is completed. Drive stakes *A* and *C* in solidly about 3′ from and facing the hub. Leave 12″ above ground, or a length several inches above the top of the proposed monument. Sight by eye and drive *B* diagonally opposite *A*, and then *D* opposite *C*, also 3′ or more from the hub.

Now, tie a length of fishing line or light-gauge wire to the brad in *A* and have a helper stretch it over *B* while you test with a plumb bob just grazing the surveyor's tack. When the line is centered, have the helper loop it over the brad in the side of *B* and drive a new brad where it crosses the top of *B*. Test with the plumb bob again, pull and redrive the top brad in *B* if necessary, and loop the line over this brad when satisfied that it splits the tack.

Follow the same procedure and stretch a line from *C* to *D*. The plumb bob, when it is centered over the tack, should then just touch both stretched lines.

Carefully remove both lines without disturbing the stakes, and take out the hub. Then, with a posthole augur, posthole shovel, or other suitable tool, make a hole 3′ to 4′ deep or well below the frost line.

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Press dirt 1″ to 2″ high around the rim, or build a wood form if the monument is to be much higher. Drive in reinforcing rods, pour a coarse mix of concrete almost to the top, as in Fig. 2, and finish the monument with a fine mix.

Stretch lines from the four stakes again before the concrete has set and, using the plumb bob, locate and press in a metal pin or large bolt at the point where the surveyor's tack originally stood. If a bolt is used, let the concrete set, and then punch the exact spot with a centerpunch, again guided by the plumb bob.

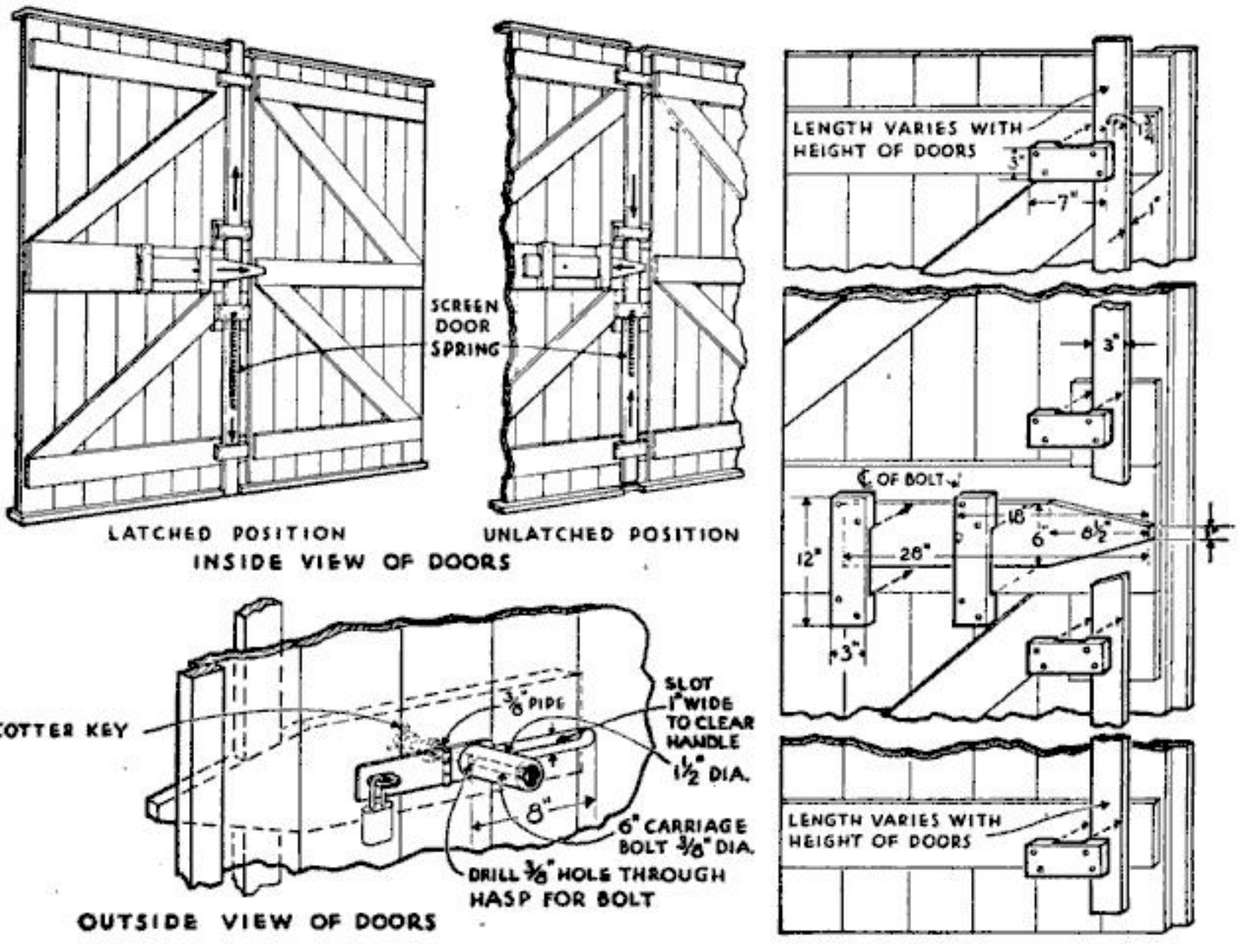
Should the neighboring owner be nonresident and unavailable, Fig. 3 shows a method of keeping monuments inside your own property to avoid any possible trouble later on. Be sure to test the corner of the opening in the ground with the plumb bob before pouring. The angle is held by long screws pressed into the concrete before it sets. Its outside corner marks the property line.—H. L. KETCHAM.

Latch Fastens Garage Door at Three Points in One Operation

MANY garage doors are equipped with a foot-operated latch that fastens them to the sill and another, operated by a pull chain and spring, that holds them closed at top. The latch shown below fastens on the inside at top, bottom, and center. It is opened or closed from the outside in one operation simply by sliding the horizontal bolt to the right or left. In addition, it is provided with a hasp for locking.

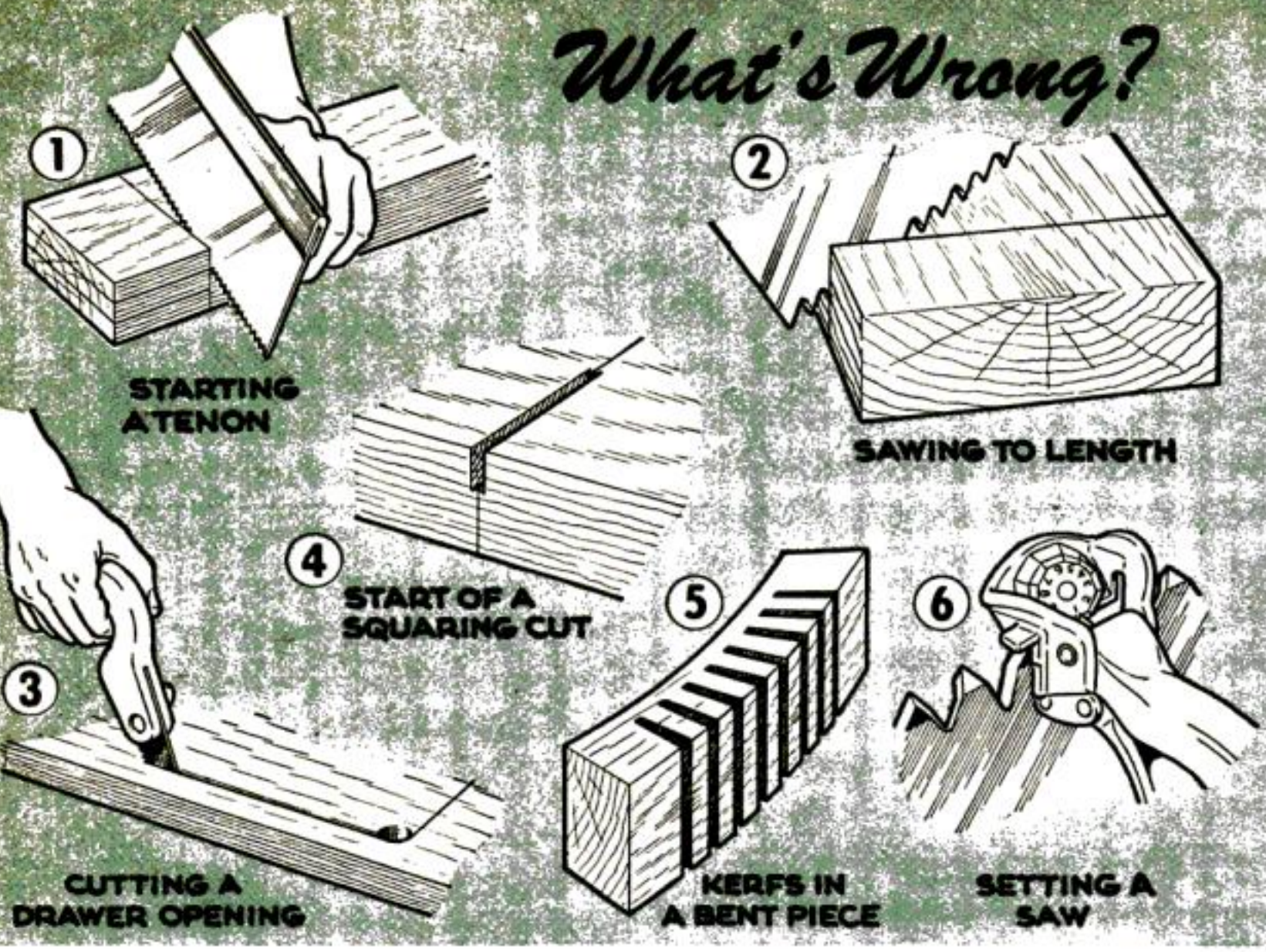
All parts are wood with the exception of the hasp and a screen-door spring that raises the lower vertical bar out of its slot in the sill when the horizontal bar is slid back and pressure is released. Be sure to get the taper on the end of the horizontal bar exactly the same as that on the two vertical bars so they can be pushed apart without binding to latch the door.

A slot in the door and batten provides clearance for a short length of pipe and a nut between the handle and horizontal bar. The handle may be a large-diameter dowel or a shaped block.—ROSCOE C. DEWITT.



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What's Wrong?



CAN you find the six errors involving saws shown in these drawings? No good carpenter would be guilty of any of them, but you may have to study the pictures carefully to discover some. The answers are given upside down below.

ANSWERS: 1. Rip tenon cheeks first.
2. The teeth show a ripsaw is being used. It should be crosscut.
3. A ripsaw should be used here as soon as it will enter the kerf. It cuts faster and is easier to guide in the wood.
4. Graze the line with the kerf in the waste for finish cuts.
5. Kerf a piece on the side toward which it is to be bent.
6. Teeth should be set outward, away from the beveled side.

LUMBER CLASSIFICATIONS [WOODWORKING]

Under standards established by the National Bureau of Standards, softwood lumber is classified as follows:

BY USE: Yard lumber. All sizes and patterns for general building purposes. Grading is based on the intended use of the particular grade and is applied to each piece with reference to size and length when graded and without consideration of further manufacture.

Factory and shop lumber. Lumber intended to be cut up for use in further manufacture. Grading is on percentage of area that will produce a specified number of cuttings of a given minimum size and quality.

Structural lumber. Lumber 2" or more thick and 4" or more wide, intended for use where working stresses are encountered. Grading is based on strength and the use of the entire piece.

BY SIZE: Yard lumber: 1. Strips. Less than 2" thick and less than 8" wide.

2. Boards. Less than 2" thick, but 8" or more wide.

3. Dimension. All yard lumber except boards, strips, and timbers; that is, yard lumber from 2" to, but not including, 5" in thickness, and of any width.

4. Timbers. Lumber 5" or more in the least dimension.

Structural lumber: 1. Dimension (joists and planks). Lumber from 2" to, but not including, 5" thick, and 4" or more wide.

2. Timbers. Lumber 5" or more in the least dimension.

(a.) Beams and stringers. Pieces of rectangular cross section 5" or more thick and 8" or more wide.

(b.) Posts and timbers. Pieces of square or nearly square cross section 5" by 5" and larger.

BY MANUFACTURE: 1. Rough lumber. Undressed as it comes from the saw.

2. Surfaced. Dressed by running through a planer. It may be surfaced on one side (S1S), two sides (S2S), one edge (S1E), two edges (S2E), or on a combination of sides and edges.

3. Worked lumber. Run through a matching machine, sticker, or molder. Worked lumber may be:

(a.) Matched lumber. Worked to provide a close tongue-and-groove joint at the edges or, in the case of end-matched lumber, at the ends also.

(b.) Shiplapped lumber. Worked to provide a close rabbeted or lapped joint at the edges.

(c.) Patterned lumber. Shaped to a pattern or molded form.

POPULAR SCIENCE MONTHLY SHOP DATA

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Designed right, to delight the most critical hobbyist

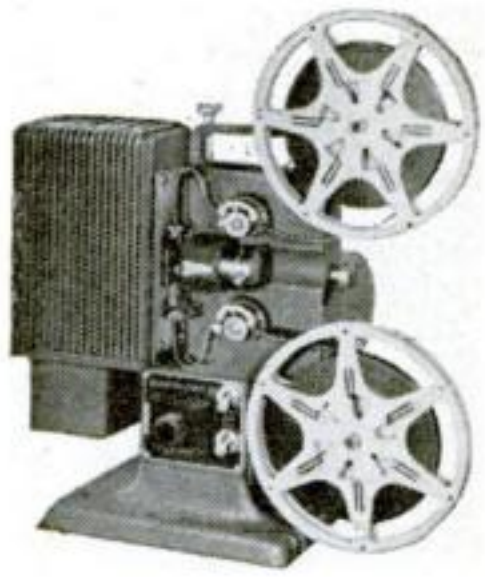
Ciné-Kodak Magazine 8

In this compact home movie camera you'll find the things you appreciate—sound design, simplified operation, the balance and "feel" of quality, combined with true film economy. Three-second magazine loading with full-color Kodachrome or black-and-white films; *Lumenized* *f*/1.9 lens; six accessory lenses; four operating speeds, including slow motion; Universal Exposure Guide.

Ask your Kodak dealer, too, about the economical Ciné-Kodak Eight-25—roll loading; with fixed-focus *Lumenized* *f*/2.7 lens, full-vision eye-level finder, footage indicator, Universal Exposure Guide. Ask about the popular "Magazine 16," too . . . Eastman Kodak Company, Rochester 4, N. Y.

Carrying Cases—Wide choice of cases for Ciné-Kodaks, film, accessories. Handsome, durable . . . complete protection for all your movie-making equipment.

Kodascope Eight-33—Fast *f*/2 lens teamed with 500-watt lamp gives brilliant image on screens up to 30 x 40 inches. Finger-tip tilting, threading, framing . . . major operating controls grouped on centralized panel.





Ciné-Kodak Long-Focus Lenses "bring it up close." Above, from left to right, (1) taken with standard 13mm. lens, (2) 25mm. lens, (3) 50mm. lens.

Kodak

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He's looking for bugs

He's hoping, of course, that he doesn't find any. Because in the manufacture of files, the best way to keep out "bugs" (defects) is to keep looking for them. Nicholson inspectors do that endlessly—through scores of inspections and tests. They begin with the scrutinizing of every batch of steel and continue down to the "ringing" test for soundness and a final check on the appearance of the finished file.

Pictured above is a "spot" examination, through a hand magnifying glass, of a file that has just come from the cutting machine. Its purpose is to make sure that the file's teeth are properly raised and correct in shape for the kind of filing job they are to do.

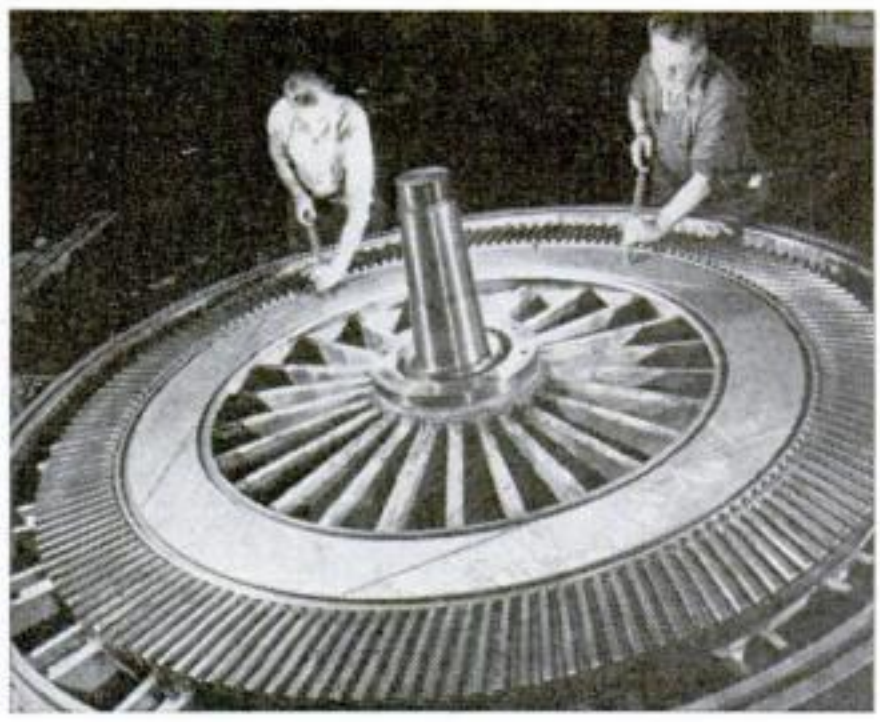
It is "eternal vigilance" like this that helps to maintain the Nicholson high standard of quality and uniformity, and enables your hardware dealer to sell you Nicholson or Black Diamond files under the sweeping guarantee of *Twelve perfect files in every dozen.*

NICHOLSON U.S.A.

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19 Acorn St., Providence 1, R. I.
(In Canada, Port Hope, Ont.)

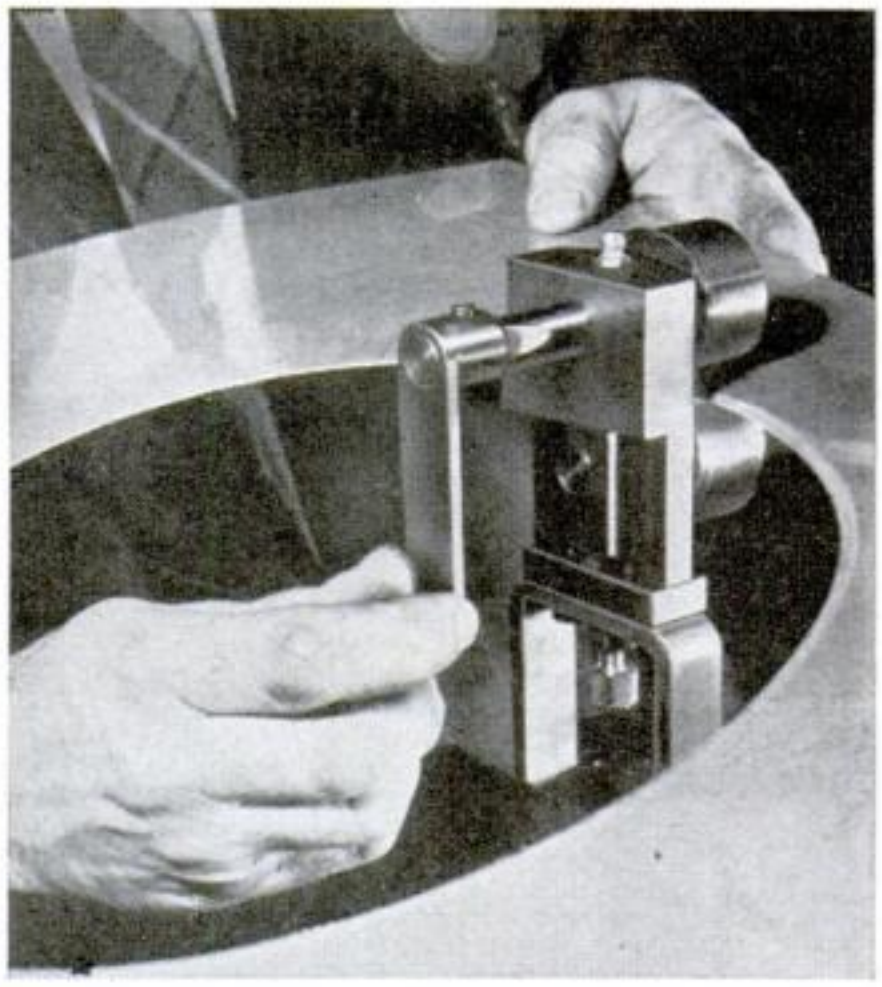
BLACK DIAMOND TRADE MARK

NICHOLSON FILES *FOR EVERY PURPOSE*



Turntable Grinds True

THRUST bearings for water-wheel generators are machined to a surface smoothness of 1/100,000 inch by the Westinghouse turntable above. The special-alloy bearings, mounted on the rotating bedplate in flattened-doughnut fashion, are ground by progressively milder abrasives to microscopic smoothness.



Handy Sheet-Metal Crimper

A TOOL that crimps sheet metal at the bench, on the job or after installation has been devised by Frank Lucarelli, of The Glenn L. Martin Co., Baltimore. Similar to a can opener, it handles metal as heavy as 16 gauge, of any shape.

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RECORD-BREAKER EVERY WAY by FRANK WILLIAMS

STEVE **VAN BUREN**- BRILLIANT HALFBACK OF THE PHILADELPHIA EAGLES

...LAST YEAR HE WON THE NATIONAL FOOTBALL LEAGUE'S GROUND-GAINING TITLE WITH 832 YARDS AND SCORED 18 TD's FOR A NEW ALL-TIME 10-GAME MARK!



KNOWN AS THE "WHAMBAM MAN", HE'S A SHY, MODEST CHAP FROM LOUISIANA STATE WHO DOESN'T THINK HE'S ANY GOOD DESPITE THE FIGURES IN THE RECORD BOOK!

AW-SHUCKS



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...STREAKING DOWN THE FIELD WITH THE PIGSKIN...



HE FEELS **SHARP!**

...BOOTING THE BALL. STEVE'S A GREAT PUNTER...WHAT'S MORE, THE ONLY TWO PLACEMENT KICKS HE TRIED DURING THE SEASON HELPED HIM AMASS 110 POINTS FOR THE 1945 POINT-GETTING TITLE!



HE IS **SHARP!**

...STEVE ALWAYS USES **GILLETTE BLUE BLADES** WITH THE SHARPEST EDGES EVER HONED...THAT'S BECAUSE THEY GIVE HIM THE SLICKEST, MOST REFRESHING SHAVES A FELLOW CAN HAVE AND SAVE HIM MONEY, TOO! YOU CAN'T FOOL STEVE--DOUBLE EDGES MEAN DOUBLE ECONOMY!

look SHARP feel SHARP be SHARP

use Gillette Blue Blades

with the SHARPEST edges ever honed!



5 for 25¢

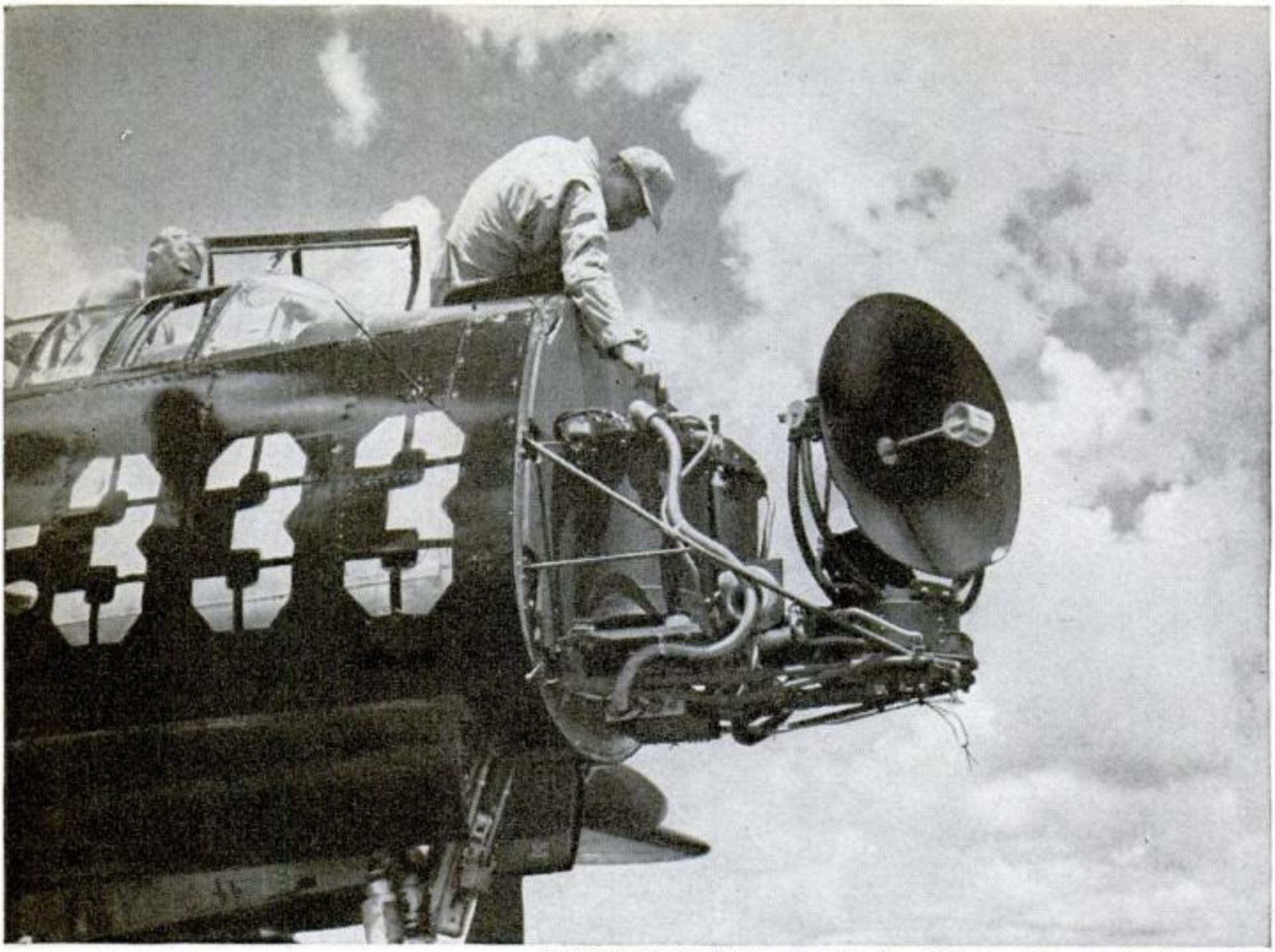
● You *look* sharp for you enjoy the swellest shaves ever. You *feel* sharp because they're refreshing and give you a lift. You *are* sharp for you get far more shaves per blade and save money. Ask for Gillette Blue Blades.

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Gillette Safety Razor Company, Boston 6, Mass.

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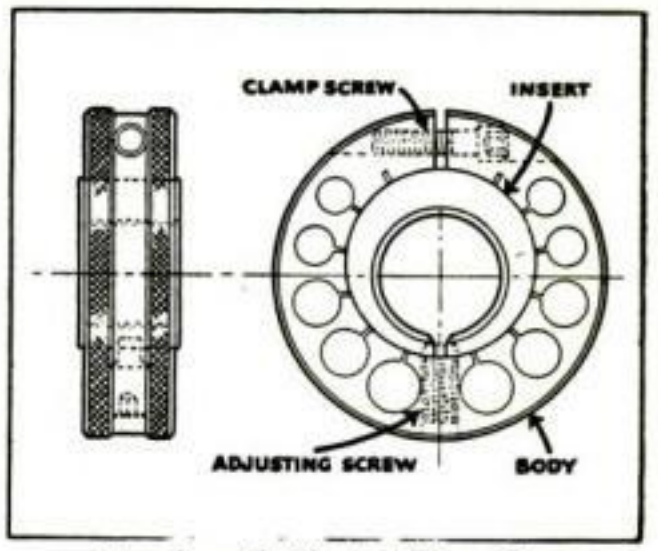
New Thread Ring Gage Starts Round *Stays Round* with every Adjustment!

Employing a new principle of design, the Woodworth Thread Ring Gage closes in round within .0002 maximum after .005 adjustment. It offers greater accuracy and stability since size adjustment is controlled along thread helix angle. Threads are held securely in alignment after adjustment, due to unique adjustment means. Wear is distributed over full circumference for all resettings, thus increasing life of gage.

Positive adjustment makes it almost impossible to change setting with ordinary knocks. Positive identification by a green "go" gage and red "not go" gage saves operator time. Aluminum alloy outer body cuts weight in half, to reduce operator fatigue and increase sensitivity.

To also reduce fatigue on precision jobs, many plant owners make chewing gum available for workers. Tests show that the act of chewing aids in relieving tension, which is often the cause of fatigue. These tests further reveal that chewing Wrigley's Spearmint Gum, for instance, helps workers stay alert, thus increases their efficiency to do more accurate work.

You can get complete information from N. A. Woodworth Company
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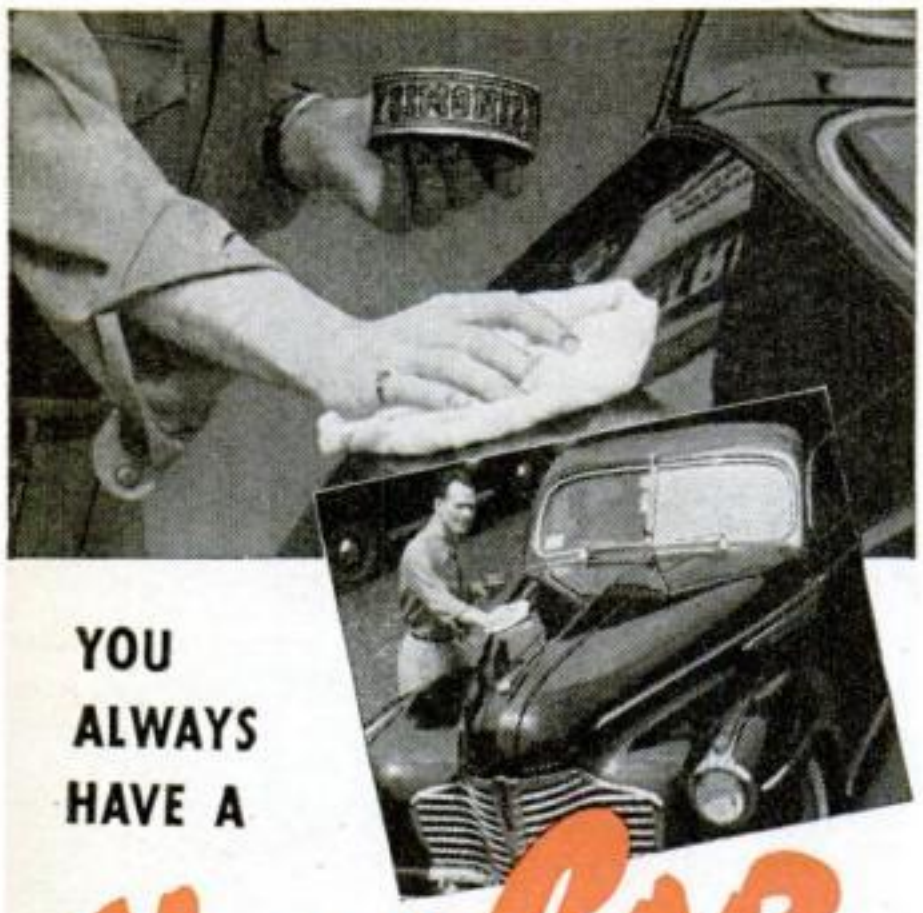


Woodworth Thread Ring Gage



AA-97

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YOU ALWAYS HAVE A

NEW CAR

IN THE PALM OF YOUR HAND

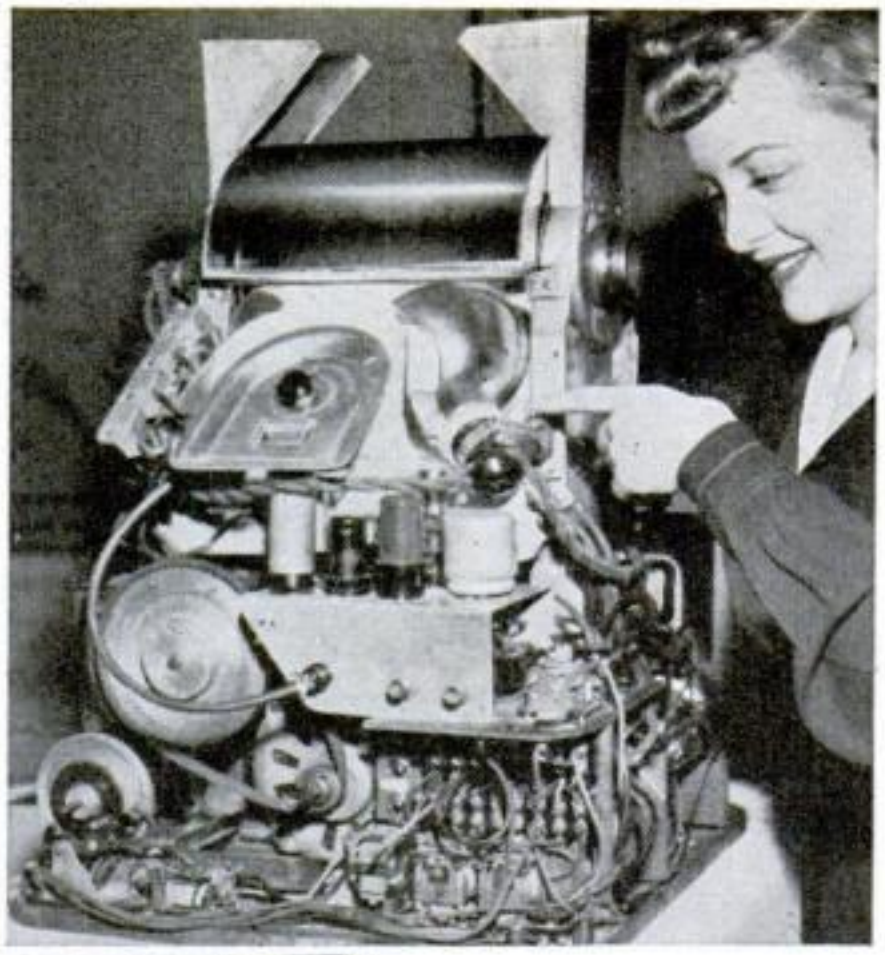
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Look again—new car or old? You can't tell by the finish because millions of motorists SIMONIZ from the start . . . and that keeps any car looking like new always. It saves the finish from damage by gritty mud, corrosive airborne chemicals and ultra violet rays. Saves washing, too. A dry cloth wipes off dust and dirt without scratching. If the finish on your car is already dull, restore the beauty with Simoniz Kleener . . . then apply SIMONIZ for protection.

THE SIMONIZ COMPANY, CHICAGO 16, ILLINOIS
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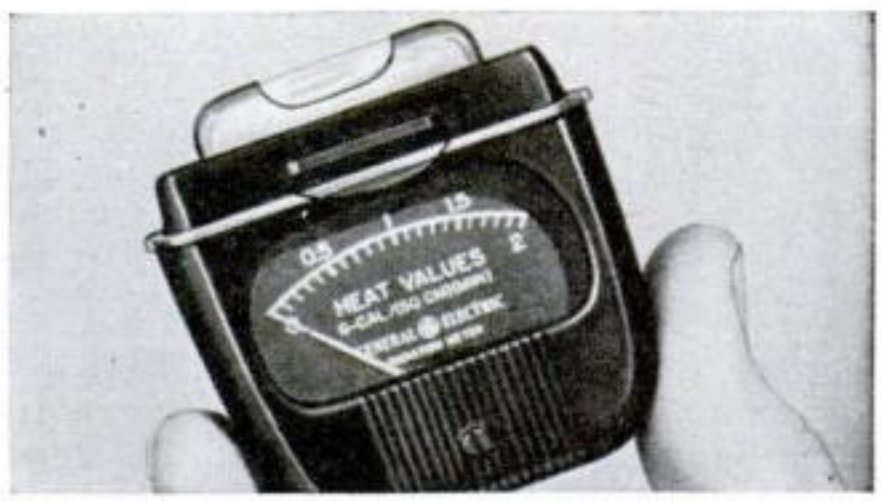
"Simoniz" . . . T. M. Reg. U. S. Pat. Off. & Foreign Countries





Electronics Runs a Coffee Roaster

COFFEE soon may be roasted to order on the grocer's counter. An electronic coffee roaster (at left and above), invented by August S. Torres, Medellin, Colombia, toasts the green beans in a preheated agitating drum until a photo-electric unit, no longer receiving radiation reflection from them, releases the beans.



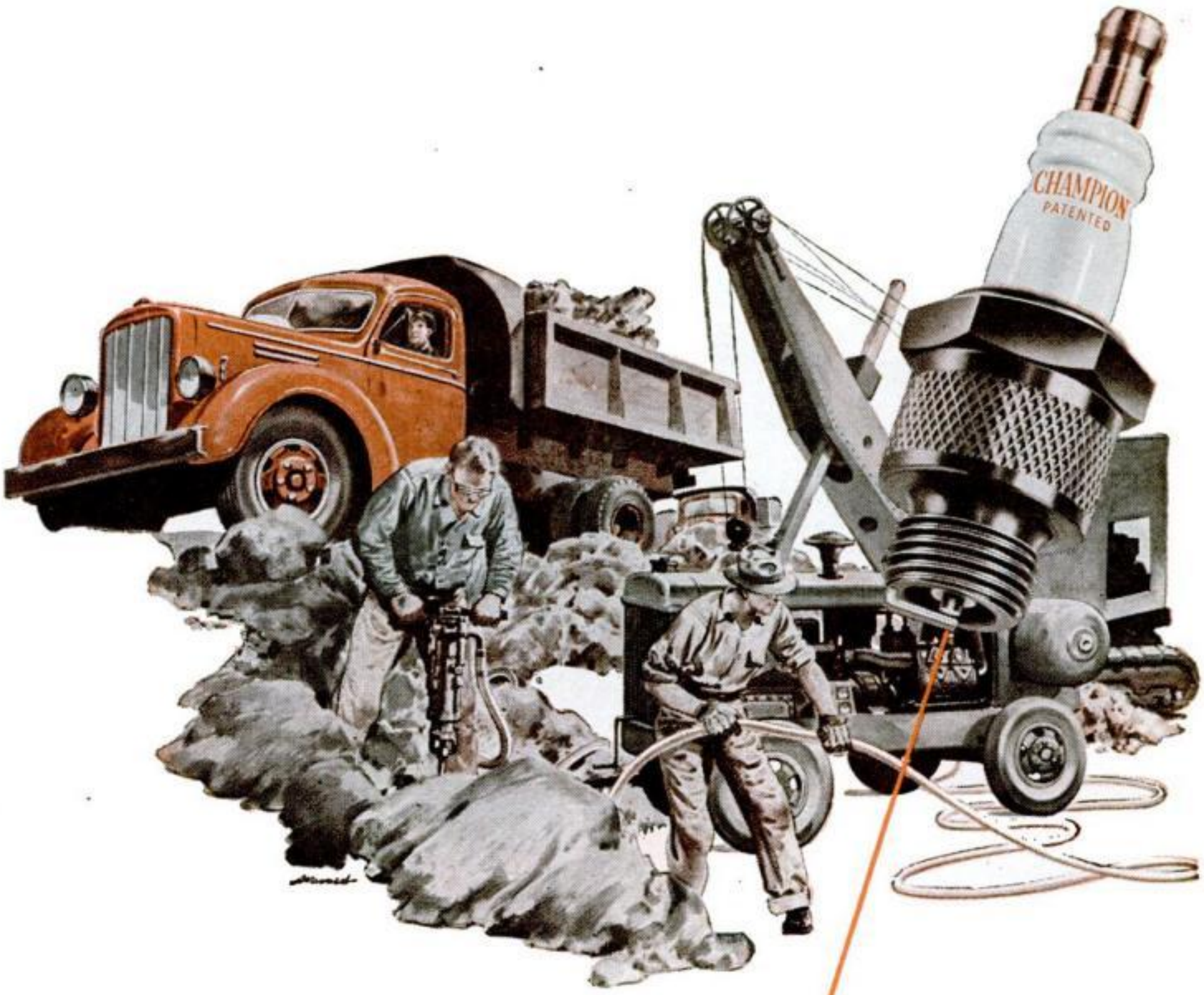
Thumb-Size Radiation Meter

THIS radiation meter, a sensitive thermocouple, was built by General Electric to measure the sun's radiation. It is sensitive to wave lengths from .3 to 3.5 microns.

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The Favorite Spark Plug for Tough Jobs . . .

CHAMPION

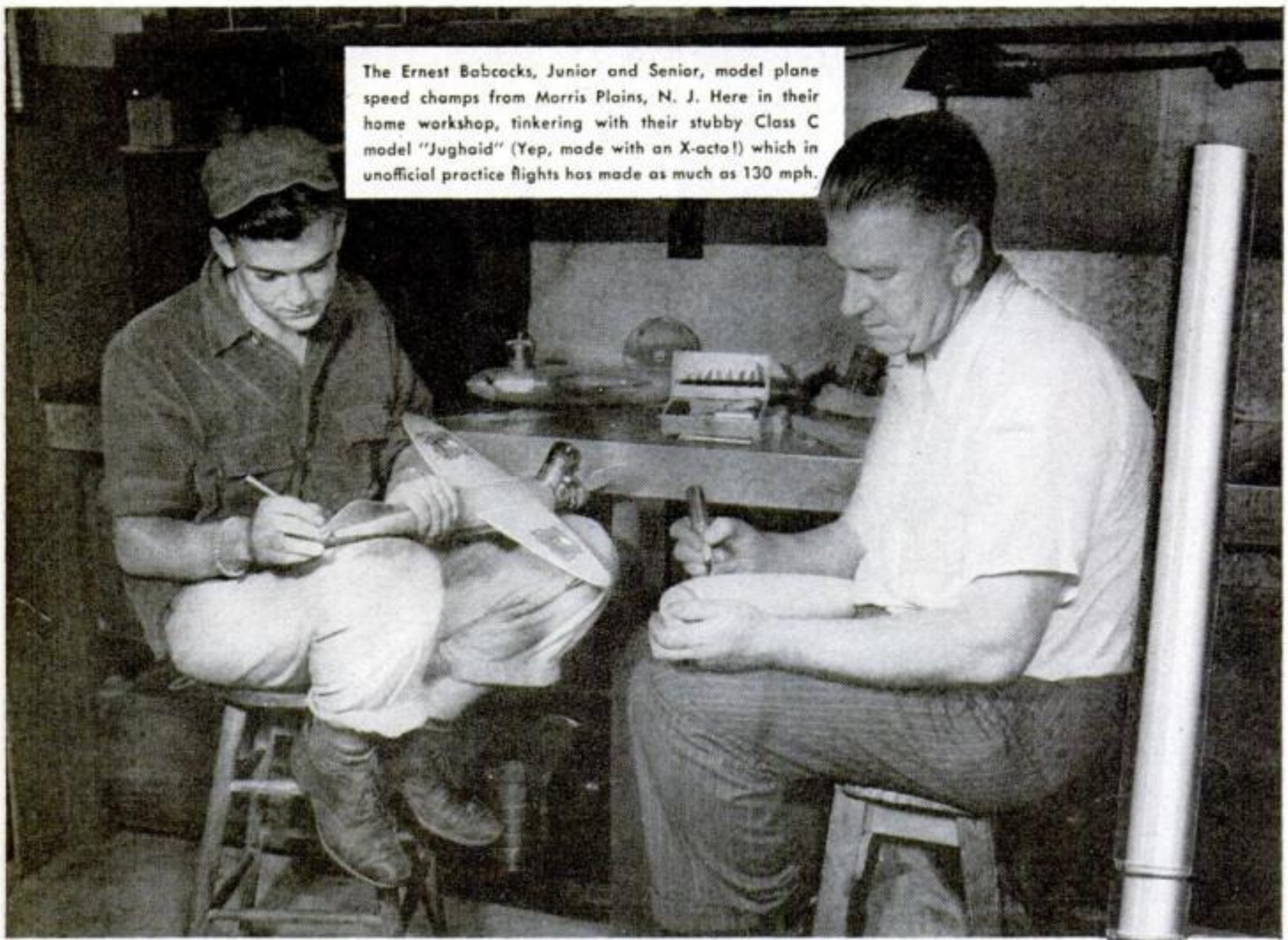


On most construction jobs, dependable gas engine power is essential. Such tough and rugged service calls for day-in-and-day-out dependability from spark plugs—and here, as in all types of service on land, water and in the air, Champion Spark Plugs are preferred and used by the overwhelming majority. Here's powerful evidence that Champions make every engine a better performing engine. Champion Spark Plug Company, Toledo 1, Ohio.



FOLLOW THE EXPERTS

DEMAND CHAMPIONS FOR YOUR CAR



The Ernest Babcocks, Junior and Senior, model plane speed champs from Morris Plains, N. J. Here in their home workshop, tinkering with their stubby Class C model "Jughaid" (Yep, made with an X-acto!) which in unofficial practice flights has made as much as 130 mph.

MEET THE CHAMPS...THE BABCOCK TEAM

...and read what *they* say about X-acto!

When thirteen-year-old Ernest Babcock asked his Dad for a model plane kit four Christmases ago, he got an X-acto Knife Chest, too. But, neither father nor son dreamed, then, that they'd become the nationally famous model plane team they are today.

Dad designs the planes, Junior flies them, but *both* work at building them with their trusty X-actos. Together, the amazing Babcocks have broken more records and run away with more top prizes than most ordinary mortals ever heard of.

Anyone who ever put a knife to wood knows a brilliant record like this takes more than expert skill in designing and handling the planes. It takes the patience of a saint in building accurate models. And it takes good, dependable tools.

So when the Babcocks say, "We've used X-acto Knives since we first began building models, and find them *the handiest tools to have in a model shop*" . . . there's a tip for *you*, brother!

13 Blade Shapes Quickly Interchangeable!

X-acto is tops, as well, for whittlers, paper sculptors, or any other hobbycrafter, be he amateur or expert. With 13 scalpel-sharp blades and 3 safety-grip handles (*all-metal, no more substitute plastics!*) you'll do a slicker job, and *quicker*, when you use super-sharp X-acto.



ALL METAL
X-acto No. 2 Solid Duraluminum Knife . . . **50c**
With 5 assorted blades, $1. Other X-acto Knives, Tools, Chests, 50c to $12.50.



Hobbycrafter's Dream Gift. No. 85 X-acto Tool Chest—3 all-metal knives; full assortment of blades; saw; sander; stripper; planer; drills and holders; steel ruler; complete in wooden chests. $12.50.

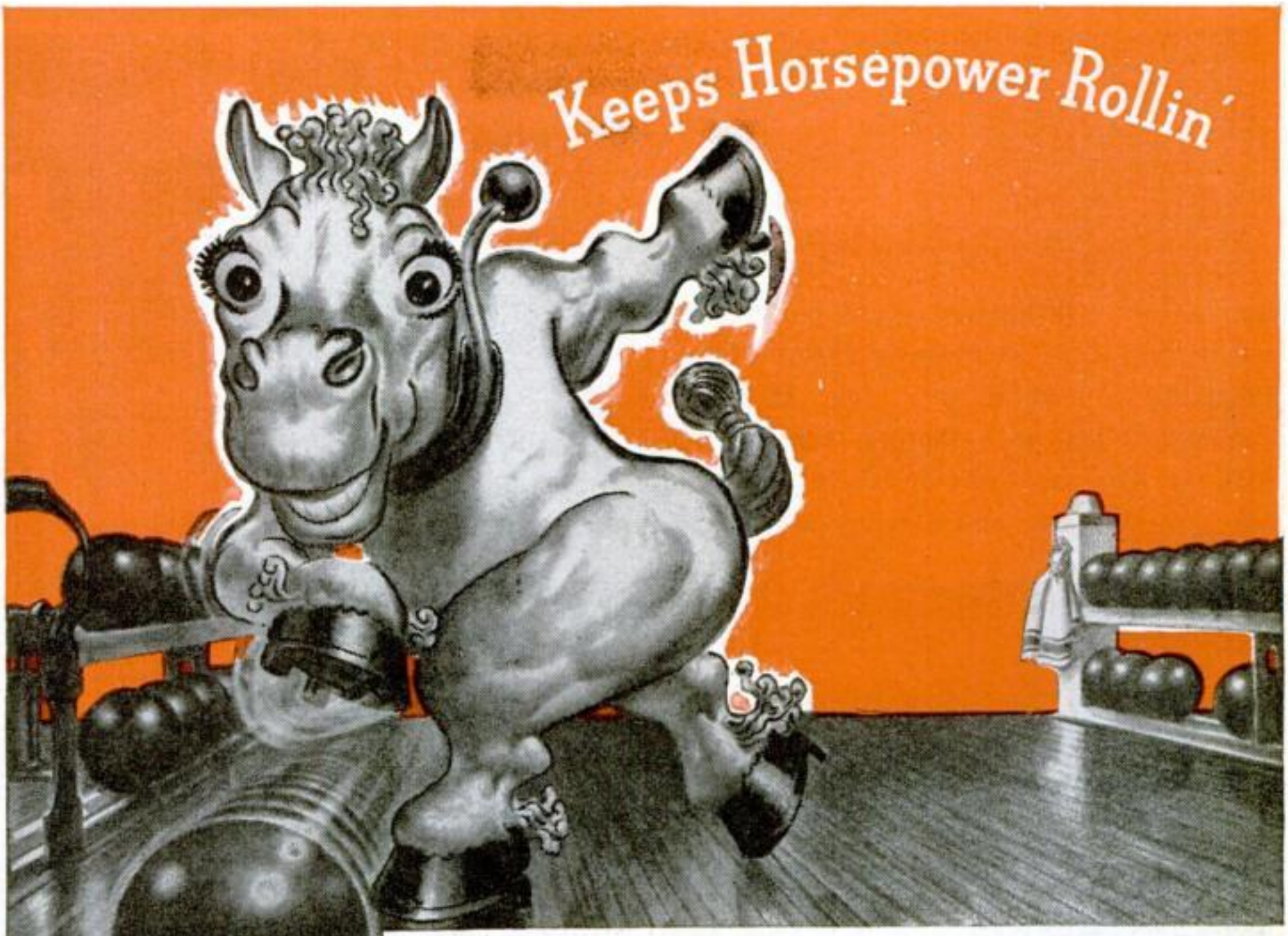
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Get your car ready for the cold weather ahead. Knock that "winter starting problem" for a row of ten pins—with Casite! Even at sub-zero, Casite retards congealing of oil—lets motors spin over rapidly for fast battery-saving starts—greatly reduces start-up wear.

Casite protects new motors during the critical break-in period . . . gives old motors extra zip and power.

For quick starting in winter, put a pint in your crankcase oil now—and with every oil change—or each 1000 miles. For better and smoother performance year 'round, also put a pint through the air intake every three months. Sold by service stations, garages and car dealers everywhere.

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GUARANTEE—Add Casite to crankcase and run through air intake according to instructions, then drive your car 100 miles or for 60 days, whichever is first. If not convinced that Casite gives you better and smoother performance, you get double-your-money-back by filling out guarantee certificate and mailing it to The Casite Corporation, Hastings, Michigan. Maximum refund is $1.30 per pint, twice the nationally advertised price of Casite.

65¢ A PINT
75¢ IN CANADA



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UTMOST RELIABILITY

Dairies and milk producers use factory-recommended AC Spark Plugs to assure utmost reliability in milk delivery. Your AC dealer can supply you with factory-recommended AC's for your car, truck or tractor, designed for today's fuels and driving conditions.



Look for this sign

AC CLEANING STATION

Spark Plugs cleaned and adjusted "By the AC Method" may save as much gas as 1 gallon in 10



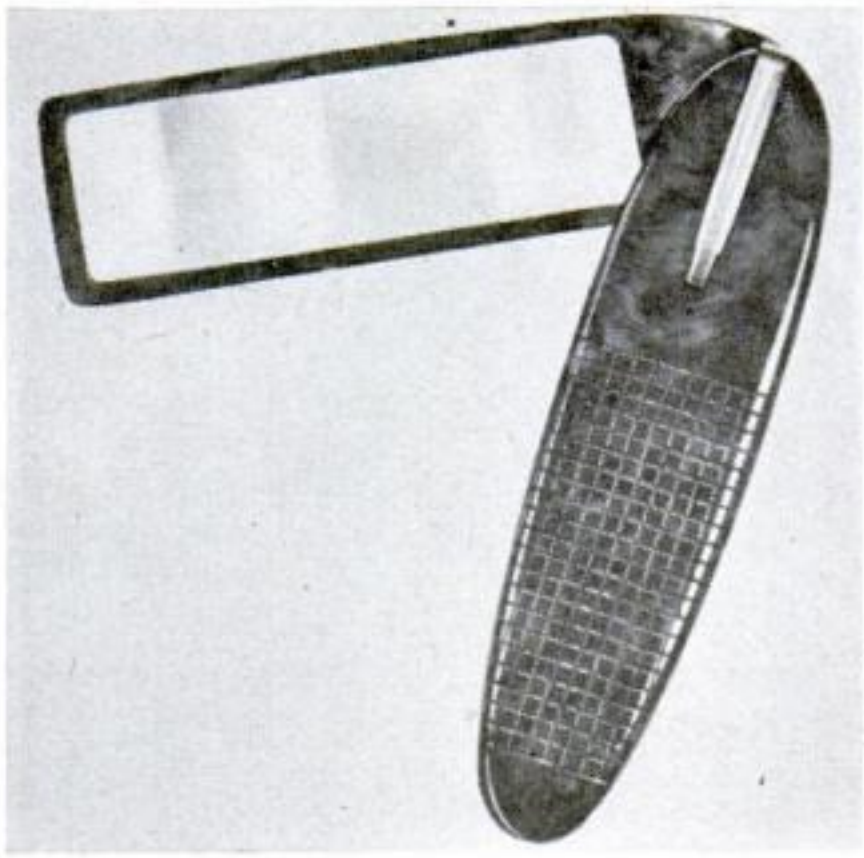
AC SPARK PLUGS

AC SPARK PLUG DIVISION • GENERAL MOTORS CORPORATION



Low-Speed Tachometer

THE NEW low-speed hand tachometer shown above permits direct measurement of speeds as low as 10 r.p.m. It consists of a double-pole, double-throw switch head, normally held in the left hand, and an indicating unit, held in the right. It is a product of the Metron Instrument Company, of Denver, Col.

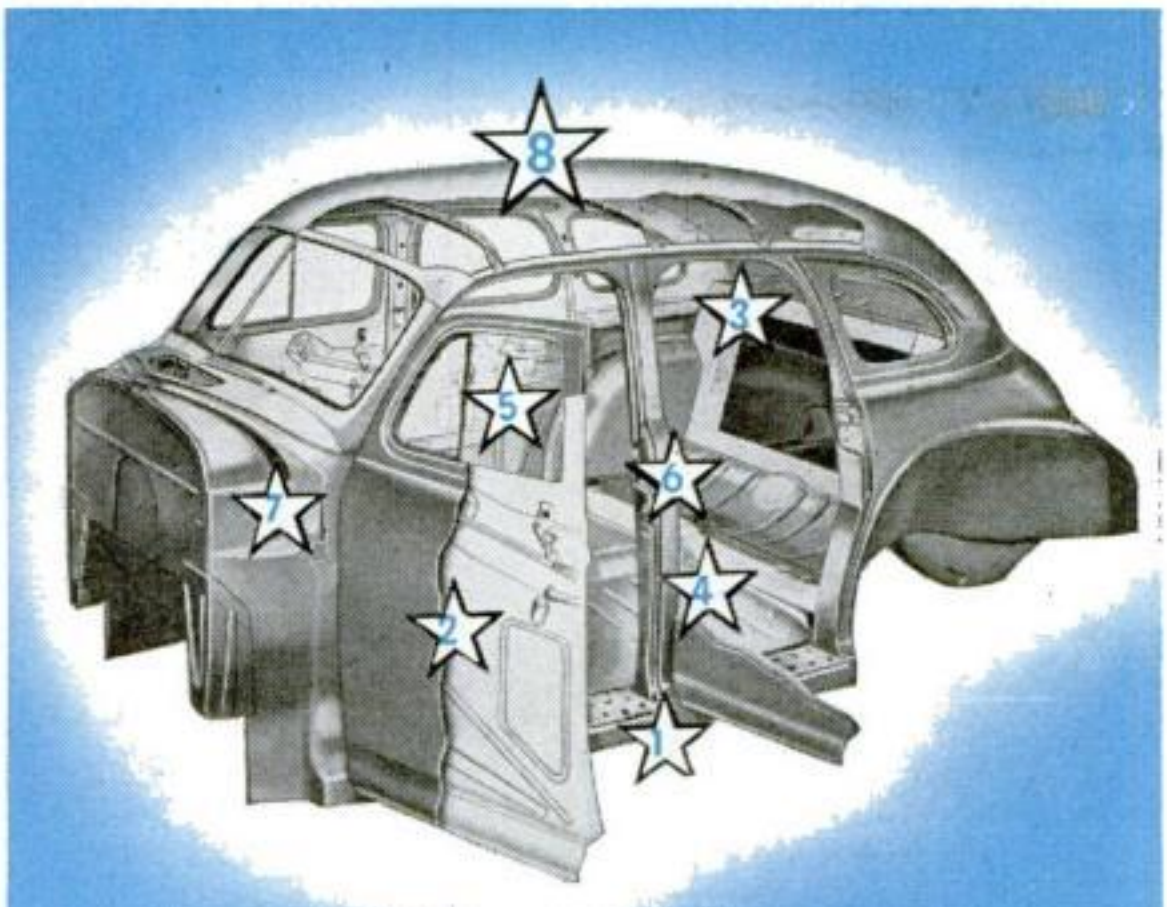


Rectangular Magnifying Glass

THE 3½-inch rectangular lens of the Longview Magnifier above permits reading of fine print or calibrations over a large area. The lens folds into the handle. It is made by Edroy Products Co.

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BETTER BY FAR IN SAFETY



THE solid security of the new Body by Fisher is doubly assured by special engineering at such points as these in the structural drawing shown above.

Inside and out, you'll find numerous evidences of the extra care Fisher Body craftsmen take to make safety certain in the bodies they build. And when it comes to beauty and comfort, you can actually see and feel the difference their special "know-how" makes.

Small wonder, then, that seven out of ten motorists say they prefer a car with Body by Fisher. Be sure your new car has one, by looking for the Body by Fisher emblem. It is your assurance of the skilled work that more than 38 years of coachcraft provide.

1. Heavier metal at vital points.
2. Outer and inner door panels welded into one solid unit.
3. Box-type rear-end braces give added protection against weaving and twisting.
4. Solid steel floor especially ribbed for extra strength.
5. Genuine safety plate glass is used in side windows and ventipanes as well as the windshield.
6. Three U-shaped steel channels welded together to form center pillar.
7. Ruggedly braced steel cowl and dash.
8. One-piece solid steel Turret Top completes the all-round safety that is yours in the Unisteel Body by Fisher.

Body by Fisher



BETTER BY FAR

Thousands of dollars in university scholarships and cash awards for best miniature Napoleonic coaches or model cars submitted by boys of 12-19 years inclusive. For information, write: Fisher Body Craftsman's Guild, General Motors Bldg., Detroit 2, Michigan.

You get Body by Fisher *only* on General Motors cars

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The New 1946 Chevrolet Fleetmaster Sport Sedan

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SURE IT'S A FOUR—

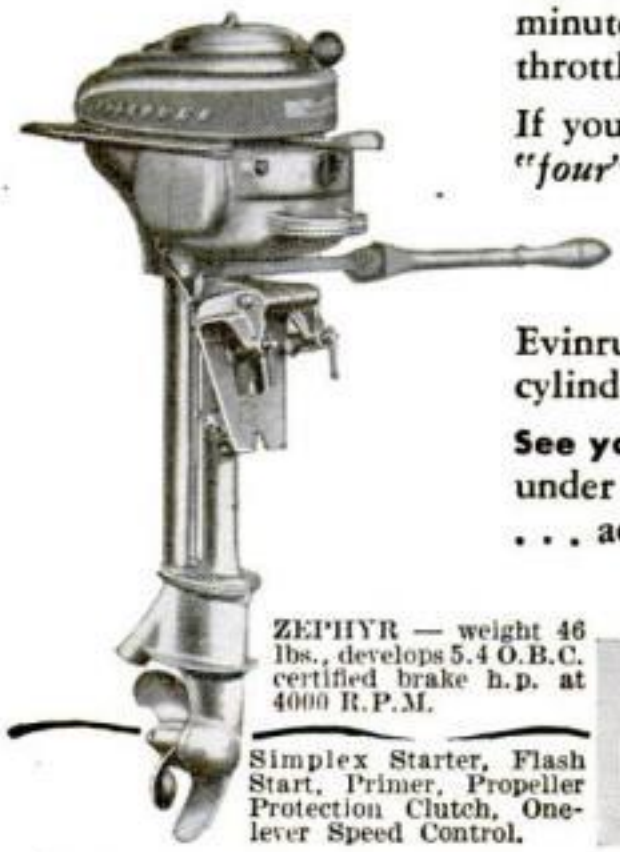
An Evinrude Zephyr! Light as a twin, smooth as silk, and a real power house!

Sounds almost too good to be true! But take the word of delighted "Zephyr" owners from coast to coast that *it is true!* Right in the range of two-cylinder power, weight and price you can enjoy matchless *four-cylinder* performance! The wonderful smoothness of 8,000 *balanced,* overlapping power strokes per minute! Exceptional starting ease! Thrilling responsiveness, and flick-of-the-throttle flexibility from slow trolling glide to surging top speed!

If you'd like a motor developing 5 horsepower or more, *you can have it in a "four"!* Four great "fours" to choose from — "Zephyr" and "Lightfour" for outstanding performance on family boats and fishing craft; "Speedifour" and "Big Four" for powering fastest outboard runabouts, cruisers, big utility boats. *Only Evinrude builds "fours"* . . . built into them is Evinrude's 37 years of outboard *Know How* . . . 18 years of leadership in four-cylinder engineering.

See your Evinrude dealer—look for his name in your classified phone directory under "Outboard Motors". Complete catalog of 8 Evinrude models sent free . . . address, EVINRUDE MOTORS, 5390 N. 27th Street, Milwaukee 9, Wis.

In Canada: Evinrude Motors, Peterboro, Ontario.



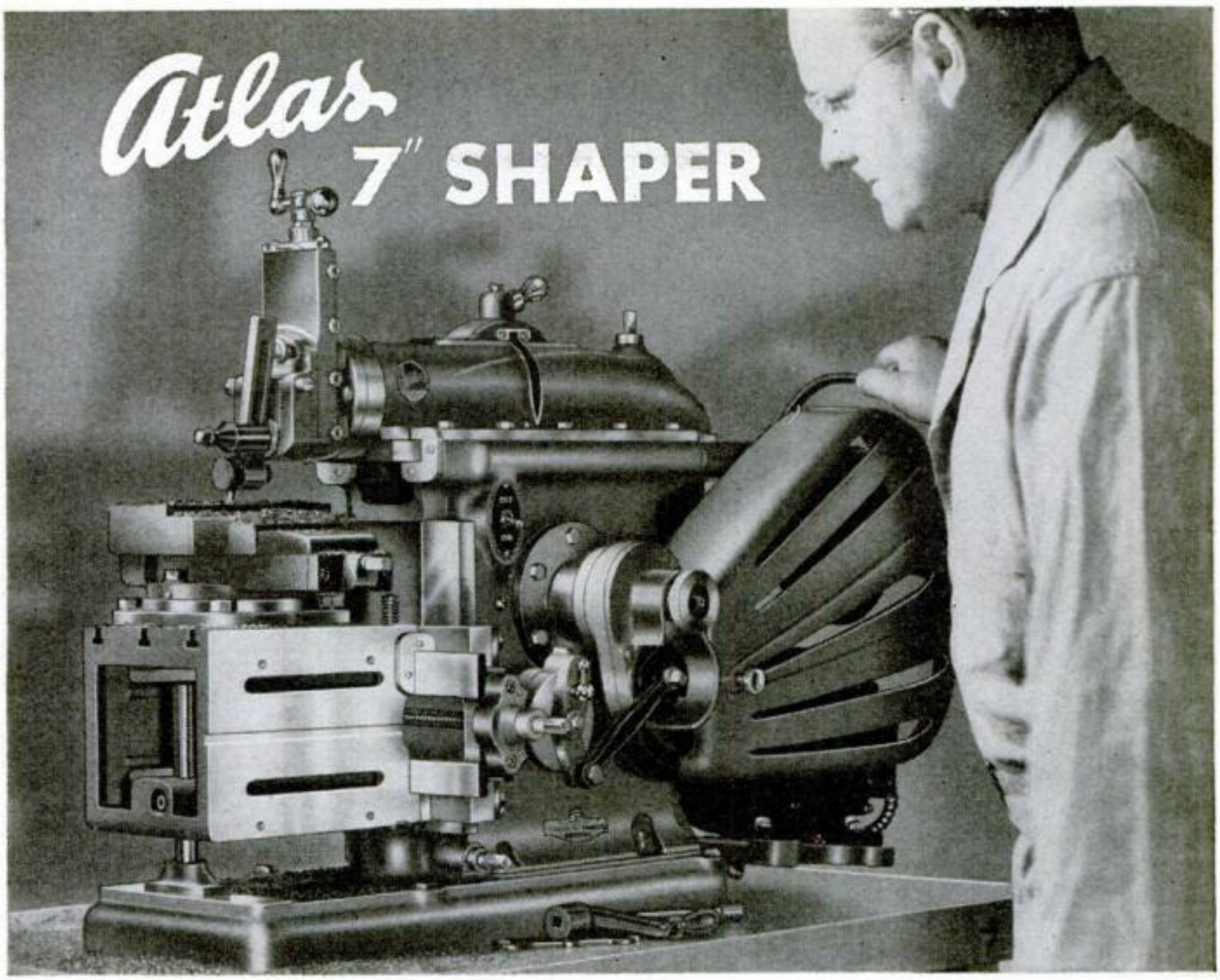
ZEPHYR — weight 46 lbs., develops 5.4 O.B.C. certified brake h.p. at 4000 R.P.M.

Simplex Starter, Flash Start, Primer, Propeller Protection Clutch, One-lever Speed Control.

EVINRUDE

OUTBOARD MOTORS

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NOW YOU CAN ADD SHAPING TO YOUR SHOP'S WORK RANGE

The Atlas shaper has all the precision and power of larger shapers built down to scale for *compactness, quick set-ups,* and *low cost* for commercial and home shops.

It performs all shaping operations to close tolerances — dovetailing, keyseating, internal work, vertical, angular, V-cuts, and others. Its 7" stroke and 9⅜" horizontal table travel machine up to 65½ sq. in. with one setting — ample for most shop requirements.

The cutting speeds range from 3½ to 116 feet per minute — feeds .005 to .025 inches per stroke. Table dimensions are 8¾" x 6" deep. Timken bearings assure smooth operation and lasting accuracy.

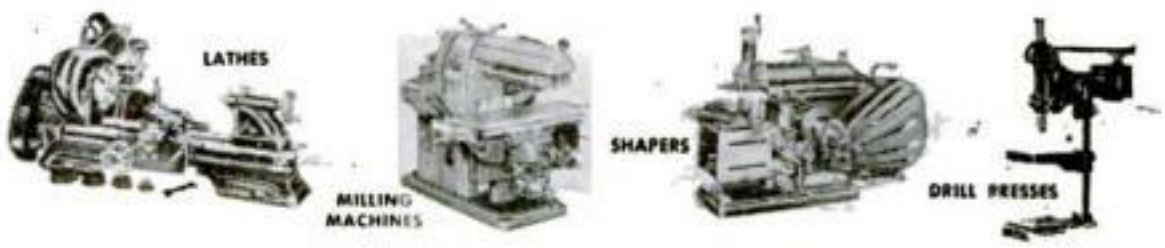
Built by advanced manufacturing methods, the Atlas shaper is most economically priced. Its operating cost is low, too — takes but a ½ HP motor. Ask your Atlas distributor for details on the shaper and other members of the Atlas 4 Tool Team.

SEND FOR
"SUCCESS STORIES"

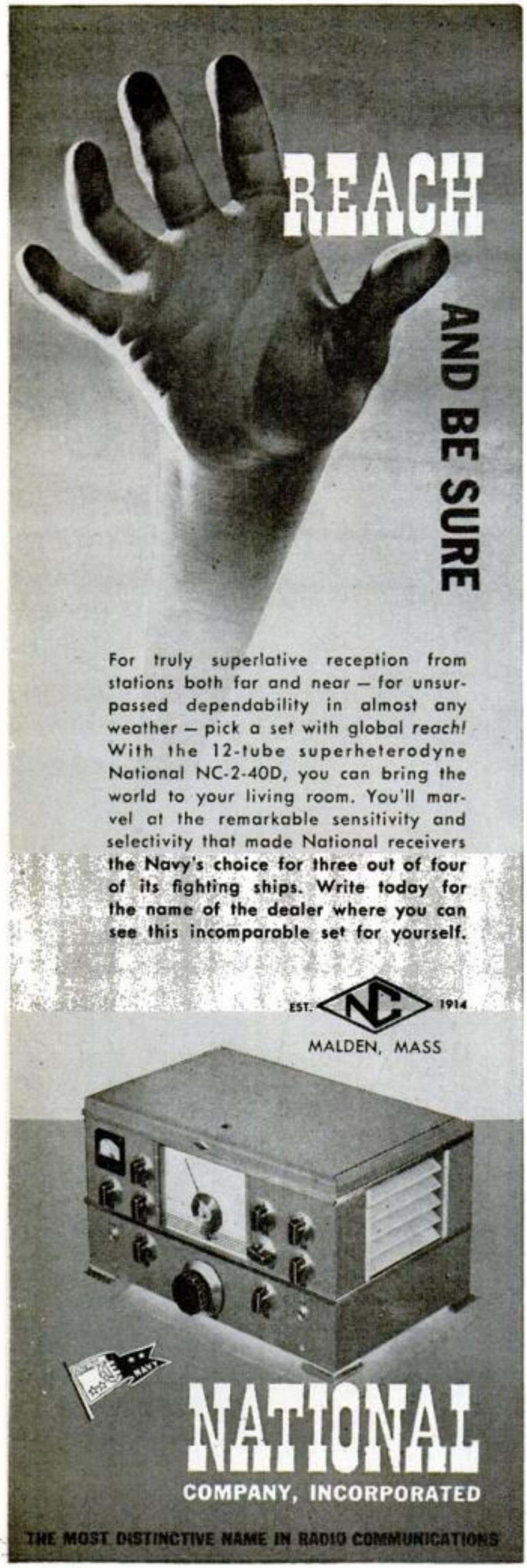
Reports of personal progress and success of men from coast to coast who have built profitable businesses starting with one or two Atlas tools. Sent free with latest Atlas catalog. Write Atlas Press Co., 1155 North Pitcher St., Kalamazoo 13D, Mich.

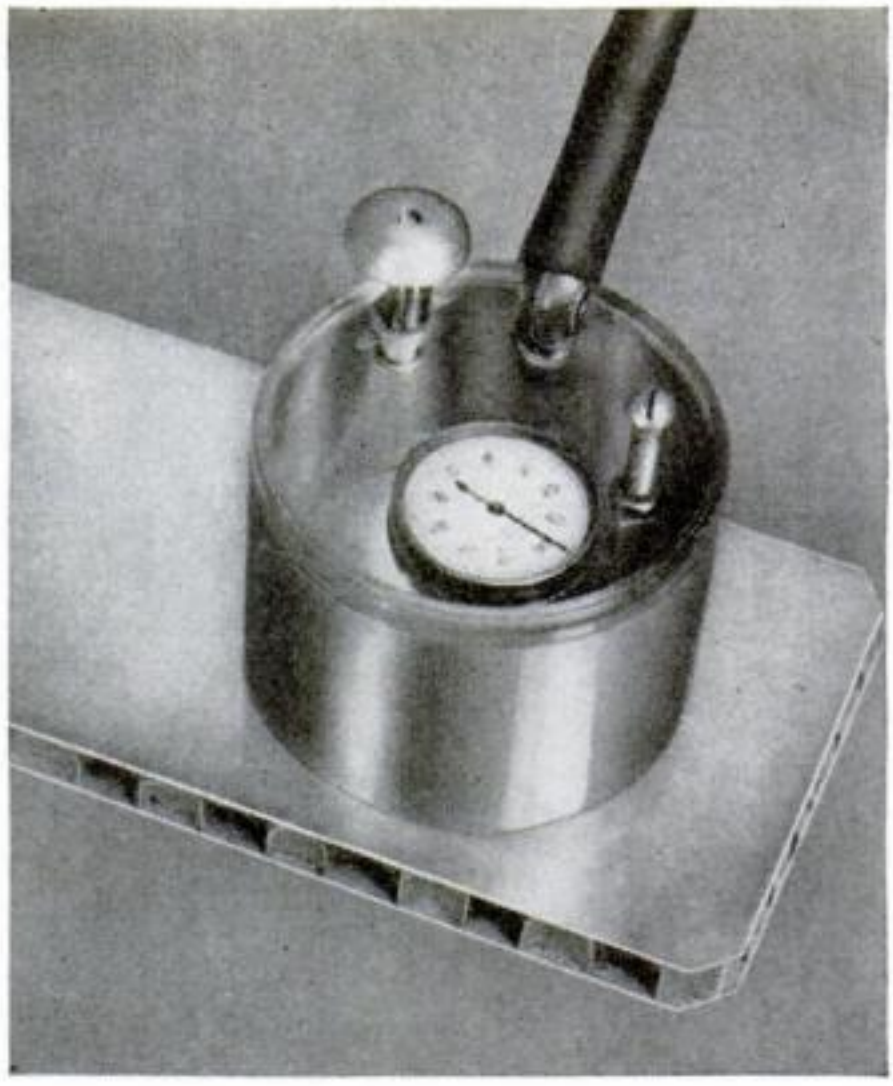


***Atlas* 4 TOOL TEAM**



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Measurement by Suction

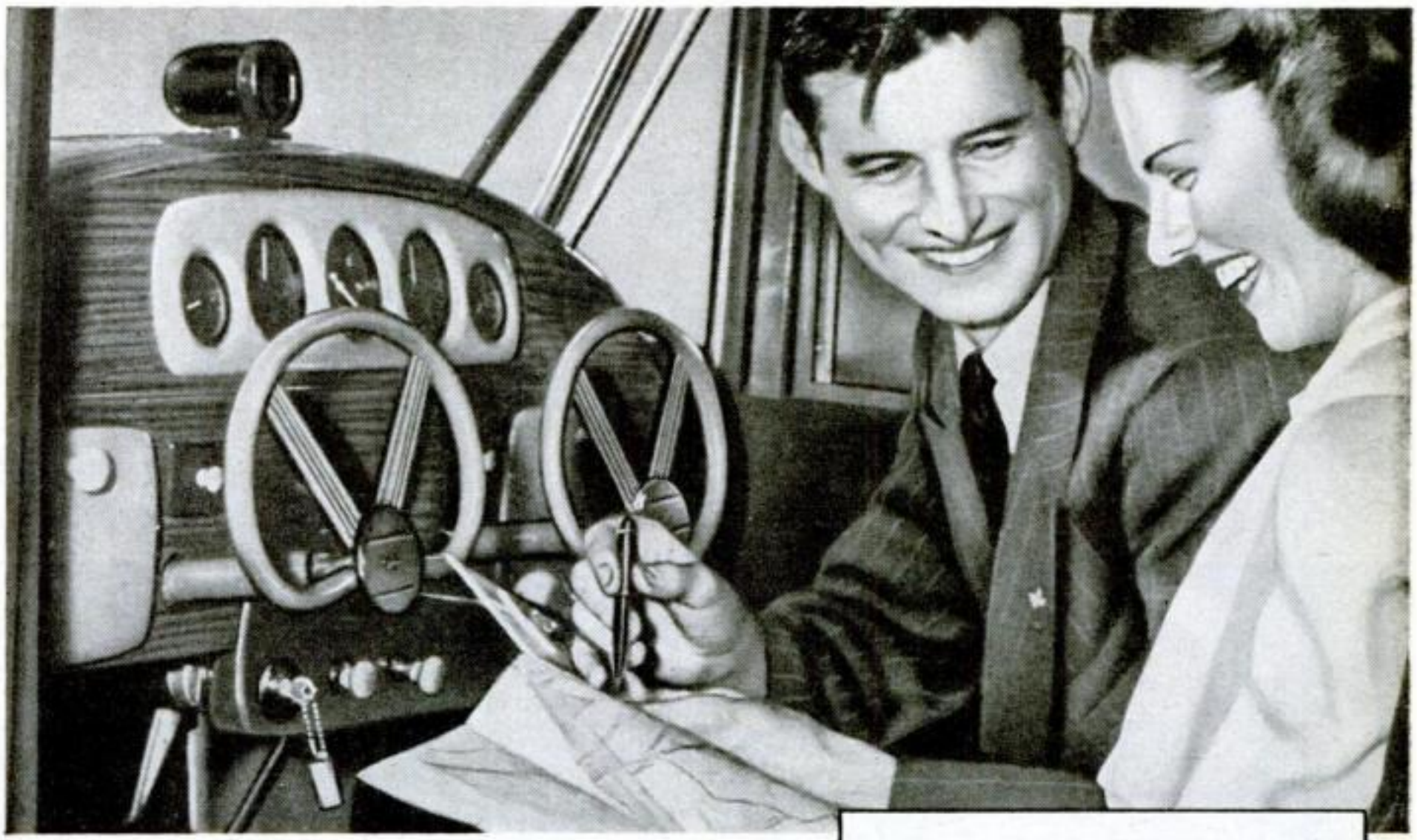
To MEASURE the thickness of sheet metal and test the bonding of laminated material, The Glenn L. Martin Co., of Baltimore, has devised a gauge operating on the vacuum principle. The cuplike gauge has a dial equipped with a stem that rests against the surface being tested. When air is pumped out of the gauge, the surface on which it rests is pulled upward, giving a reading that can be compared with known values. The gauge can be used to measure or test metal, wood or plastics.

Mouse-Squeak Test for Drugs

MOUSE squeaks induced by electric shocks, the fall meeting of the American Chemical Society was told, offer an accurate test of the efficiency of pain-relieving drugs. The shocks are applied to the tail of a mouse dosed with a specific drug; the number of 15-volt shocks it absorbs without squeaking indicates the potency of the drug in terms of morphine, which is taken as a standard. The report said that the 15-volt level was established after detailed tests of mouse "tolerance." Shocks of ascending voltages produced varied responses and descending voltages brought squeaks all down the scale, but 15 volts were found to give a measurable performance.

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They'll *be* where they want to be in no time at all. For miles mean nothing —in Aeronca!

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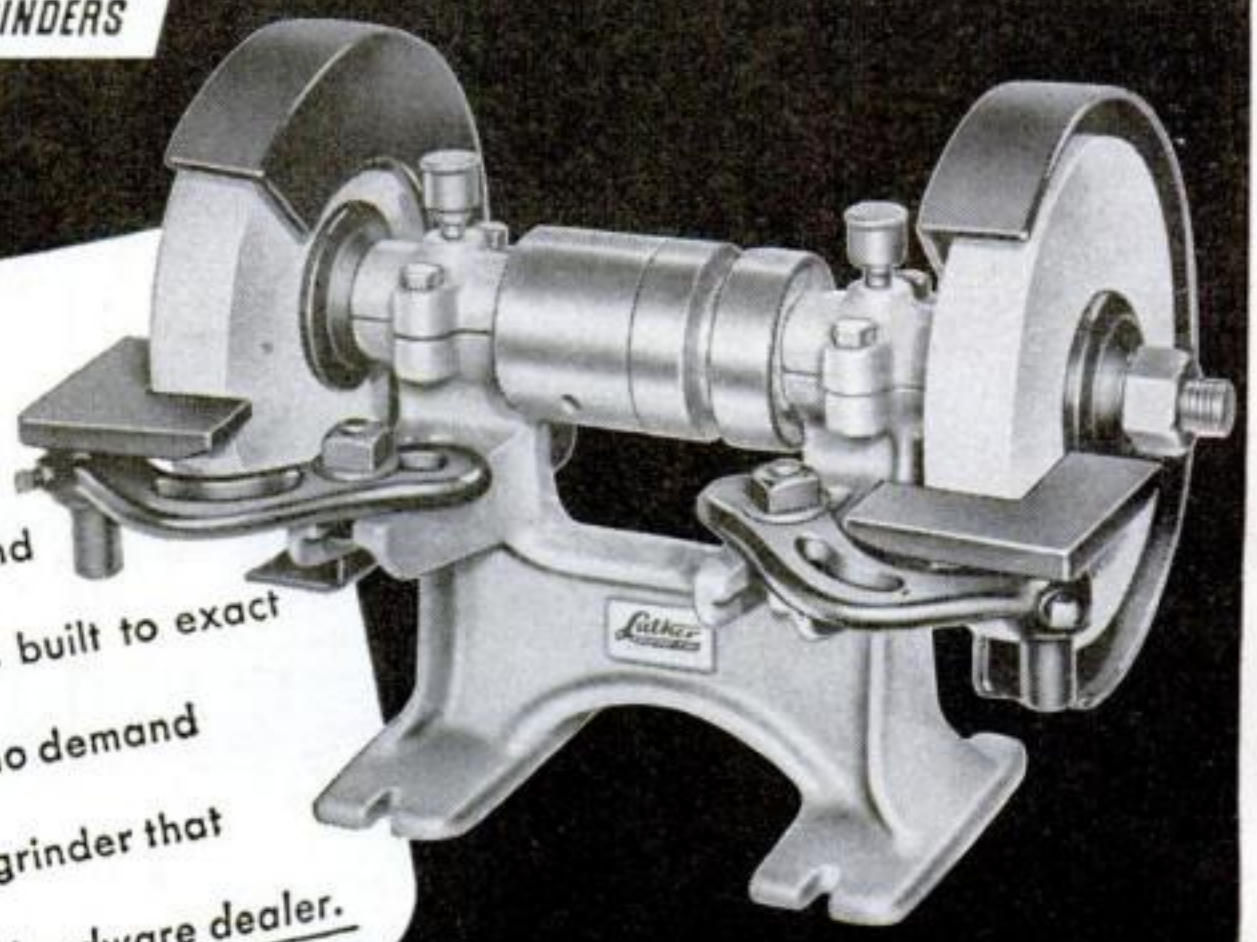


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Luther POWER GRINDERS

HAND AND POWER GRINDERS



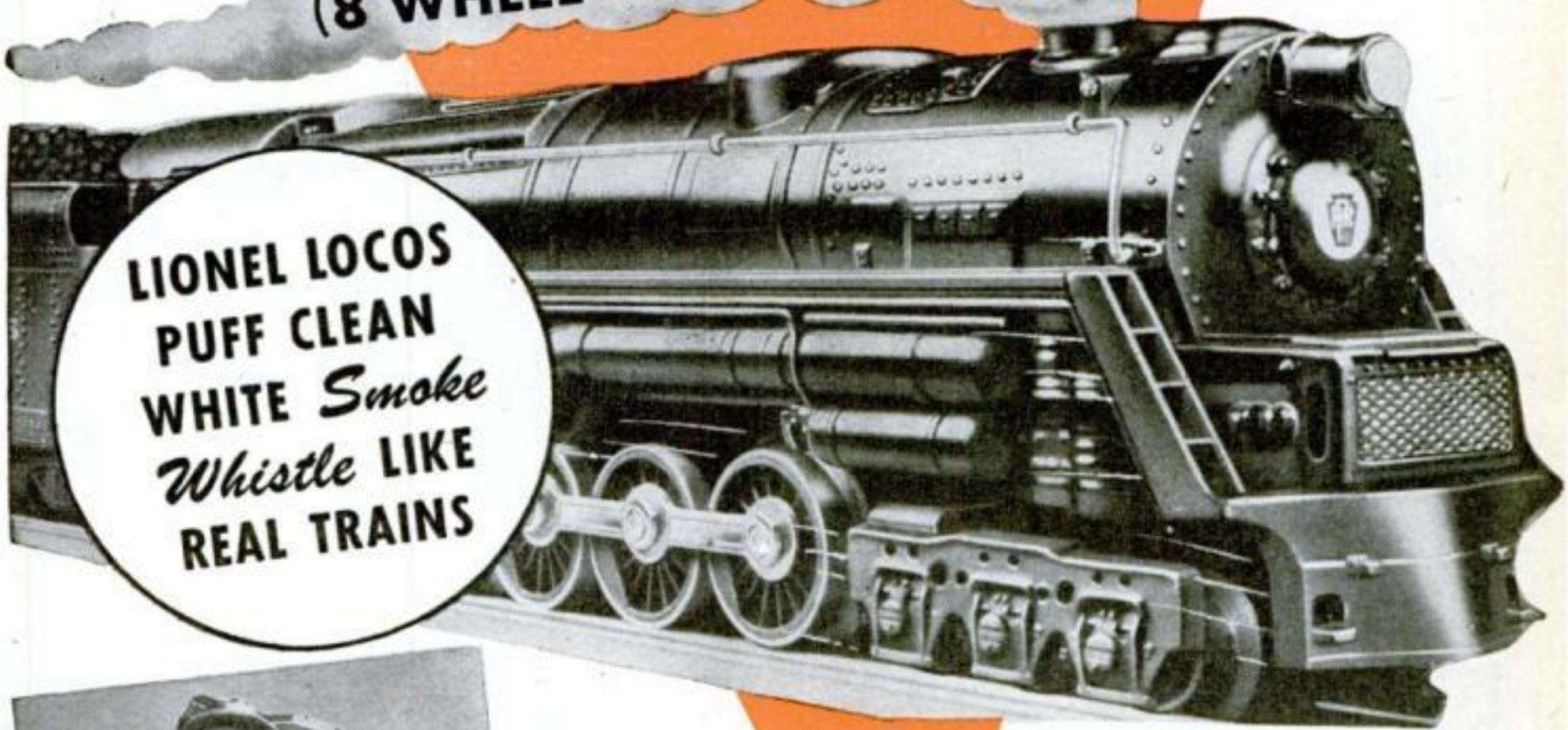
Like all Luther Grinders, the power grinder shown here is famous for high quality and rugged construction. It is built to exact specifications for those who demand fine tools. For the Luther grinder that fits your needs, see your hardware dealer.

LUTHER GRINDER & TOOL CO.
(Established 1896) **Sheboygan, Wisconsin**

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(8 WHEEL—DOUBLE WORM DRIVE)



LIONEL LOCOS PUFF CLEAN WHITE *Smoke* *Whistle* LIKE REAL TRAINS



Note realistic real railroad — remote control — electro magnetic knuckle couplers, and solid steel wheels.

This new LIONEL 20-wheel Pennsylvania Steam Turbine Loco — powered by a mighty new motor and LIONEL exclusive double worm drive is the last word in locomotive perfection. Brand new! — it is only one of the many surprises LIONEL has for you this year. Send for the new color catalog and get the full story. Again LIONEL leads the world!

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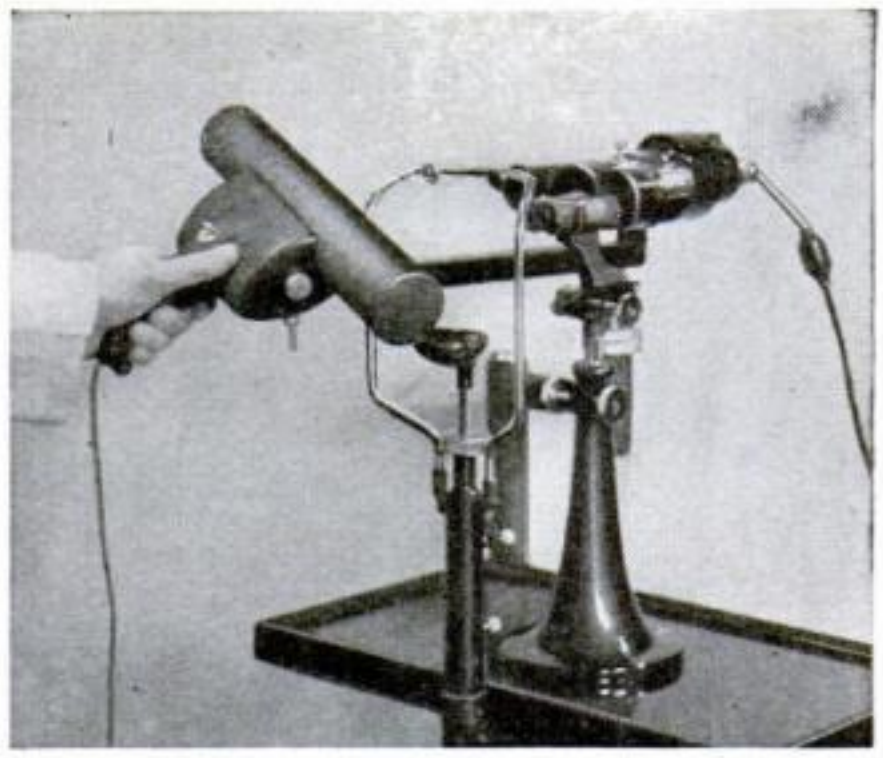
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REPUTATION—That's a good guide, too! Just remember that professional carpenters and experienced craftsmen have preferred Millers Falls Tools since 1868.

Choose tools on appearance, performance and reputation and your choice will be Millers Falls. See your dealer.

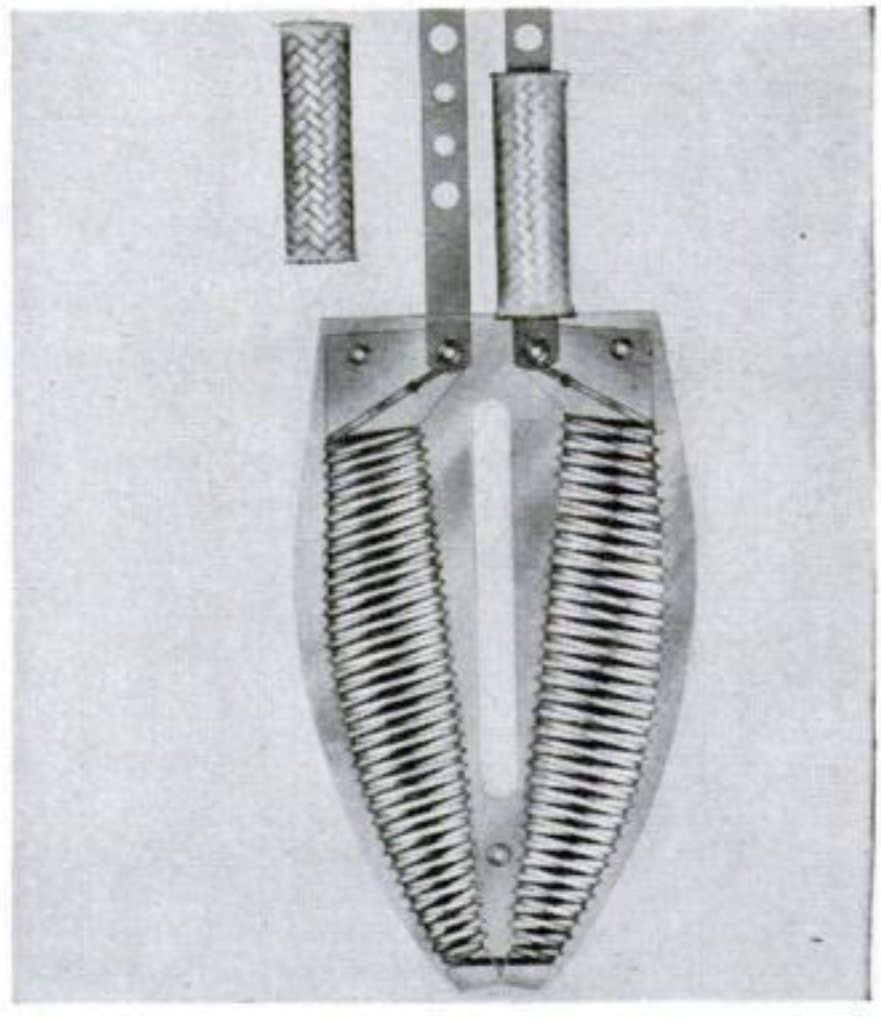
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SINCE 1868

MILLERS FALLS COMPANY
GREENFIELD MASSACHUSETTS



Lamp Disinfects Instruments

THE Germ-O-Lamp, an ultraviolet disinfecting device, has been developed for use by optometrists and eye specialists. A hand model containing an eight-watt ultraviolet bulb, it disinfects equipment or fittings that may have come in contact with a patient's skin or clothes. This method of killing bacteria takes only a minute.



Iron Replacement Element

EASILY installed, a new replacement element produced by the St. Clair Electric Products Co., of St. Clair, Mich., is designed to fit 90 percent of all electric irons. It is made of heavy mica forms wound with Chromel or Nichrome wire for 600 watts or 110-120-volt AC or DC circuits.

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AMAZING NEW BATTERY—Needs water only 3 times a year...

IN NORMAL CAR USE

Lasts longer, too!

The Auto-Lite "Sta-ful" Battery has more than 3 times the liquid reserve of ordinary batteries. In normal car use the plates are kept submerged to help deliver full life and power long after the plates in ordinary batteries are exposed and inactive.

In addition, oversize electrical capacity, plus Fibre-glass insulation, gives longer life than batteries without the Auto-Lite "Sta-ful" features.

Be sure your next battery is an Auto-Lite "Sta-ful."

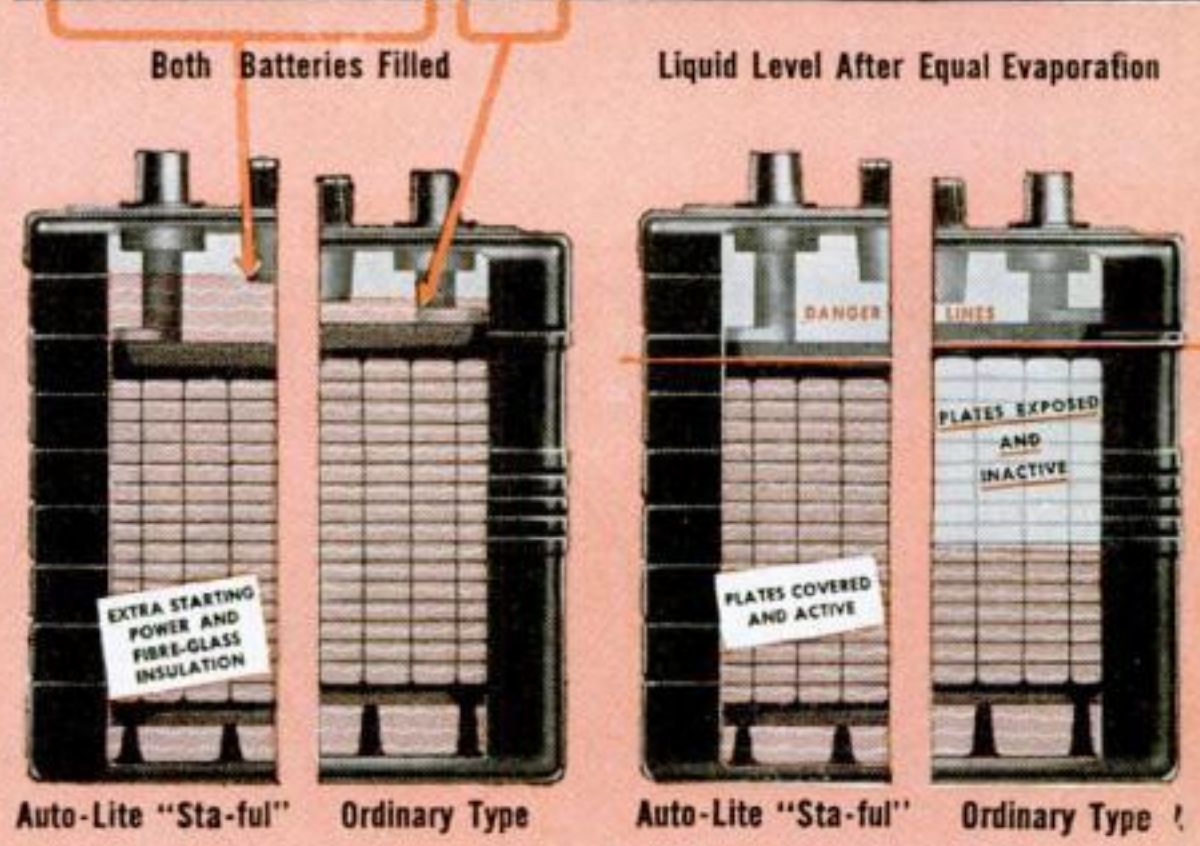
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Illustrations above show the result of equal evaporation in the Auto-Lite "Sta-ful" Battery and other batteries. As shown by illustration on the far right, plates of ordinary batteries are exposed sooner by water loss and then become inactive faster.

For sale by Auto-Lite battery dealers everywhere



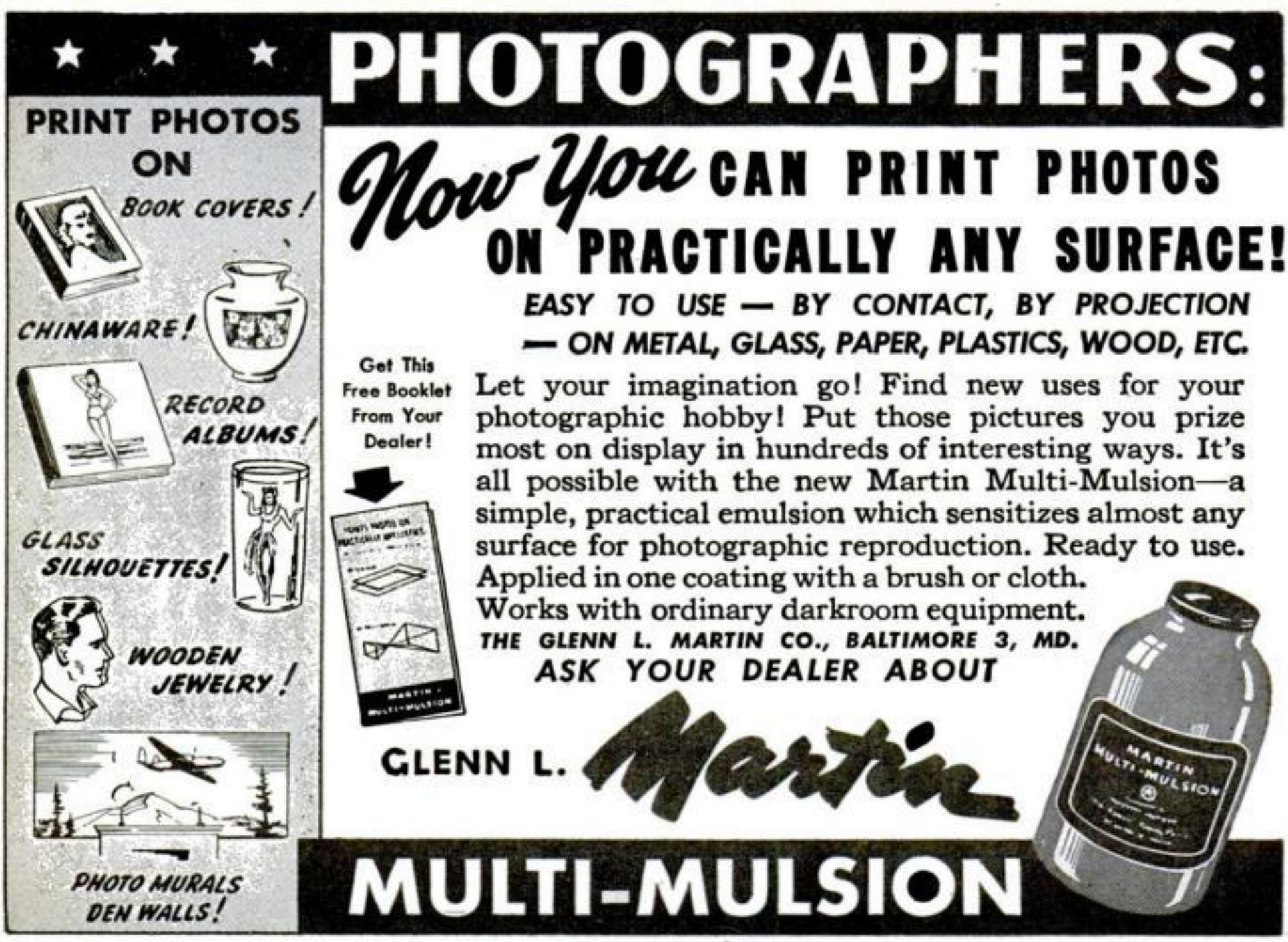
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HARLEY-DAVIDSON
Motorcycles

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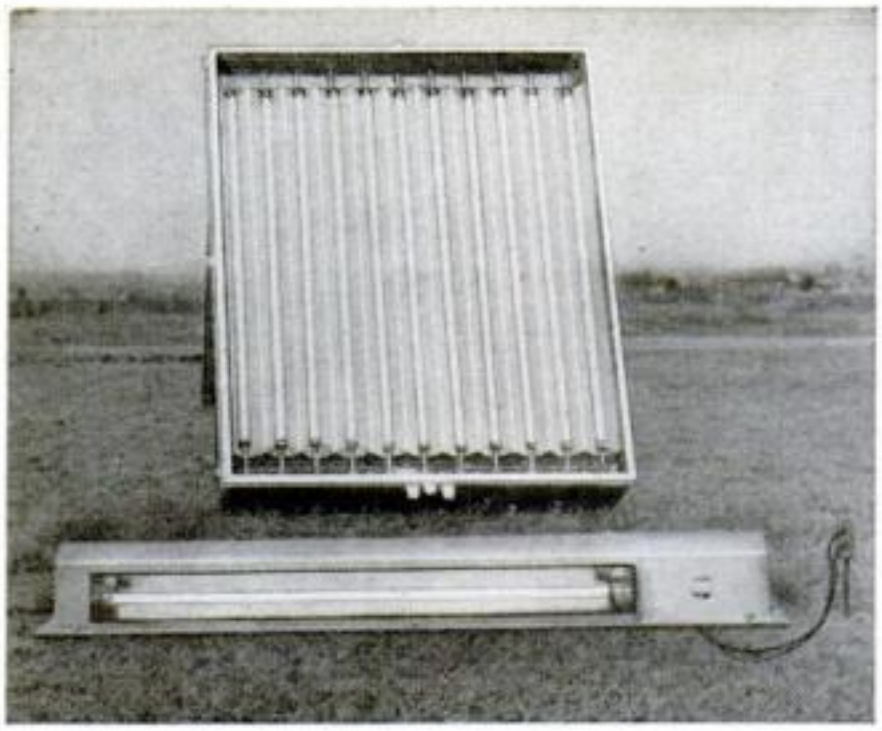
Please send at once free copy of 24-page "ENTHUSIAST" Magazine, filled with motorcycle action pictures and thrilling stories.

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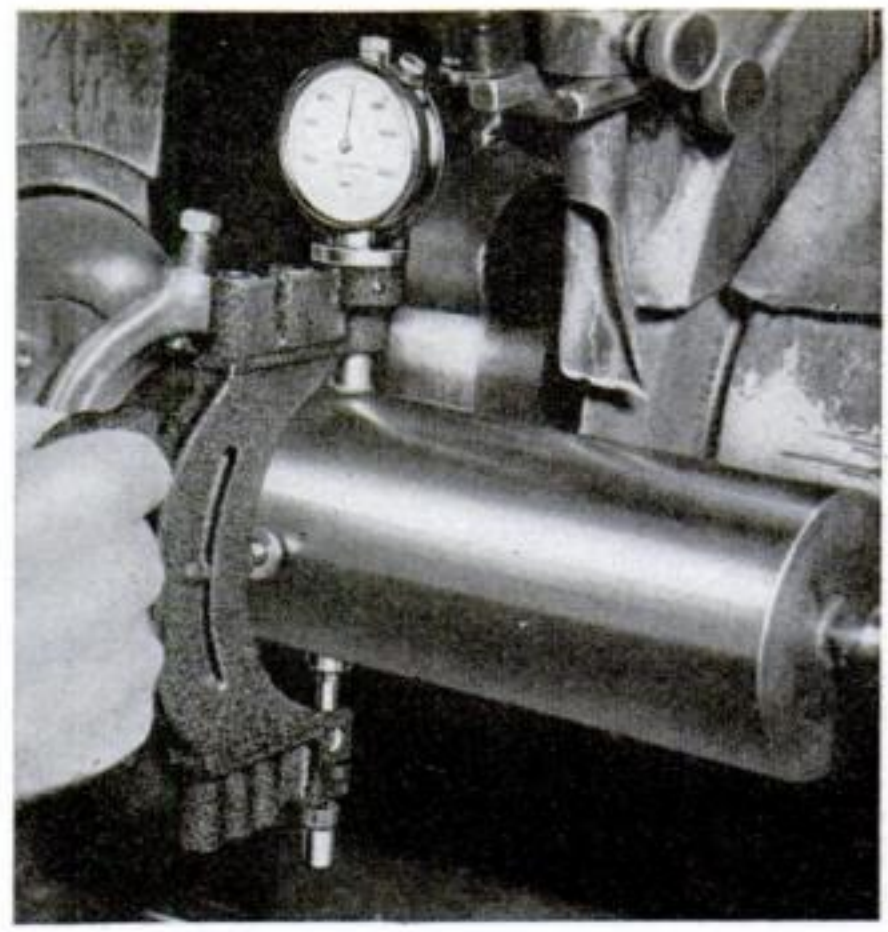
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All-Weather Airport Lights

THE new 11-tube gaseous discharge beacon in photo above facilitates all-weather landings. Called the Le-Land Blanket Unit Approach Beacon, it provides a penetrating, wide-angled flood of red light. Special parabolic reflectors cut the glare so a pilot is not light-blinded on an approach. Below it is the Le-Land Runway-Boundary-Threshold unit for marking airport boundaries and the correct runway. It throws green light on one side, red on the other.



Gauge Has Removable Heads

A SINGLE pair of demountable heads and four extension spacers of different lengths give the Decimatic Dial snap gauge a range of four inches. The gauging pins have a surface of cemented carbide to reduce wear. The tool is made by the Standard Gage Co., of Poughkeepsie, N. Y.



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$85,000 IN AWARDS FOR BOYS



Roger H. Oetting, 14-year-old student at Foch Intermediate School, Detroit, was intrigued by the Napoleonic coach. His interest and perseverance brought him the $5,000 first award in the Junior Division.



Leo C. Peiffer, 17, of Cedar Rapids, Ia., makes models as a hobby. It paid off with a $5,000 scholarship, first award in the Napoleonic coach competition, Senior Division. He enters Iowa State College this Fall.



Virgil Max Exner, Jr., 13 years old, of South Bend, is a racing car enthusiast. With his $4,000 first award in the Junior model car competition, he will enter Notre Dame, studying engineering and industrial design.



Robert J. Hartlieb, Jr., of Allentown, Pa., enrolled at 15 in the 1946 competitions. His model car scored so close to the Junior winner's that a tie was declared and an extra $4,000 award was provided. Robert wants to be an engineer like his father.



Vincent J. Rauth, 19, son of a York, Nebraska farmer, walked off with the $4,000 scholarship given as first award in the Senior Division of the model car competition. His hobby is aviation.



Eugene Schwietz is 15 and the son of a St. Paul, Minn., postal employe. He won second award in the Junior Division of the Napoleonic coach competition—a $3,000 scholarship to be used when he is ready for college.



Walter Edwin Roth, Jr., 18, Detroit, Mich., "likes to build models." Entering the Napoleonic coach competition, Senior Division, he won second honors—a $3,000 scholarship to complete his course at Wayne University.



Charles Clayton Bradley, 14, goes to Central High School in South Bend, Ind. When he finishes high school, his second place award, Junior model car section, will provide $2,000 for a mechanical engineer's education.



David Wayne Whitman, 18, of Jackson, Mich., plans to be an automobile designer. With a $2,000 scholarship, second award in the Senior model car competition, he starts at the General Motors Institute in Flint, Mich., this Fall.

1,220 awards — university scholarships, $2,000 to $5,000 each, cash awards, trips — in the Fisher Body Craftsman's Guild 1947 model-building competitions

Here are 9 boys who are well started on the road of opportunity.

They are the major award winners in the 1946 Fisher Body Craftsman's Guild competitions—and each now has a scholarship, ranging in value from $2,000 to $5,000, to be used at the university of his choice.

Now 1,220 awards, totaling $85,000 in value, are offered to boys between the ages of 12 and 19, inclusive, in the 1947 competitions.

You compete for these awards by building a model Napoleonic coach to plans supplied free — or by designing and building a model car to simple specifications. Both are real fun.

Any boy 12 years old or over and not yet 20 on September 1, 1946 may enter either competition. Junior and Senior Divisions with identical awards let you compete with boys in your own age division. There are no dues or entrance fees, and awards include cash, all-expense trips to the Guild Convention, and 8 university scholarships worth $2,000 to $5,000 each. (Duplicate awards are given if sons of GM employes win.)

A distinguished board of judges, including deans or presidents of 10 leading technical schools and universities, makes the awards.

To enter, you simply write for free membership in the Fisher Body Craftsman's Guild. In return, you receive a membership card and a full set of plans and instructions, all free. Competitions close June 15, 1947.

Why shouldn't *you* win one of these awards? Mail the coupon NOW and get started.



MODEL CAR—You build a solid model, using only ordinary tools. Awards in *each age division:* Two $4,000, two $2,000 university scholarships; 588 cash state awards ranging down from $100; 18 convention trips, all expenses paid.



NAPOLEONIC COACH—You receive complete plans and drawings, free of charge. Awards: Two $5,000, two $3,000 university scholarships; 588 cash state awards ranging down from $125; 18 convention trips, all expenses paid. *Junior and Senior awards are identical.*

FISHER BODY CRAFTSMAN'S GUILD

An educational foundation sponsored by
Fisher Body Division of General Motors

General Motors Bldg., Detroit 2, Michigan

Gentlemen: Please enroll me in the Fisher Body Craftsman's Guild for 1947, in the

☐ Napoleonic Coach Competition
☐ Model Car Design Competition

Send me full instructions without charge

Name_____

Address_____

City_____ Zone____ State____

I was born on the____ day of_____ 19____

Name of parent or guardian_____

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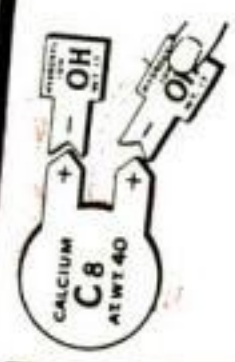
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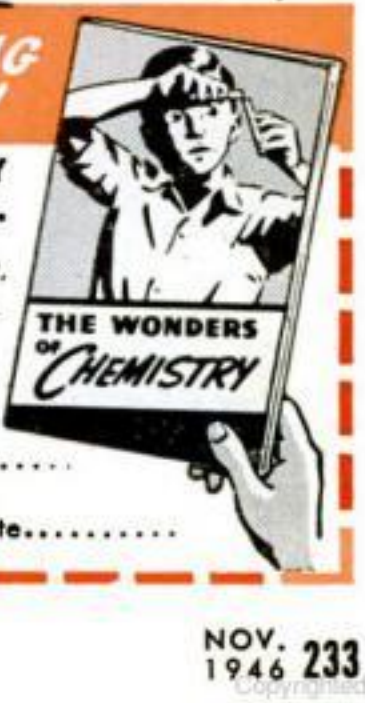
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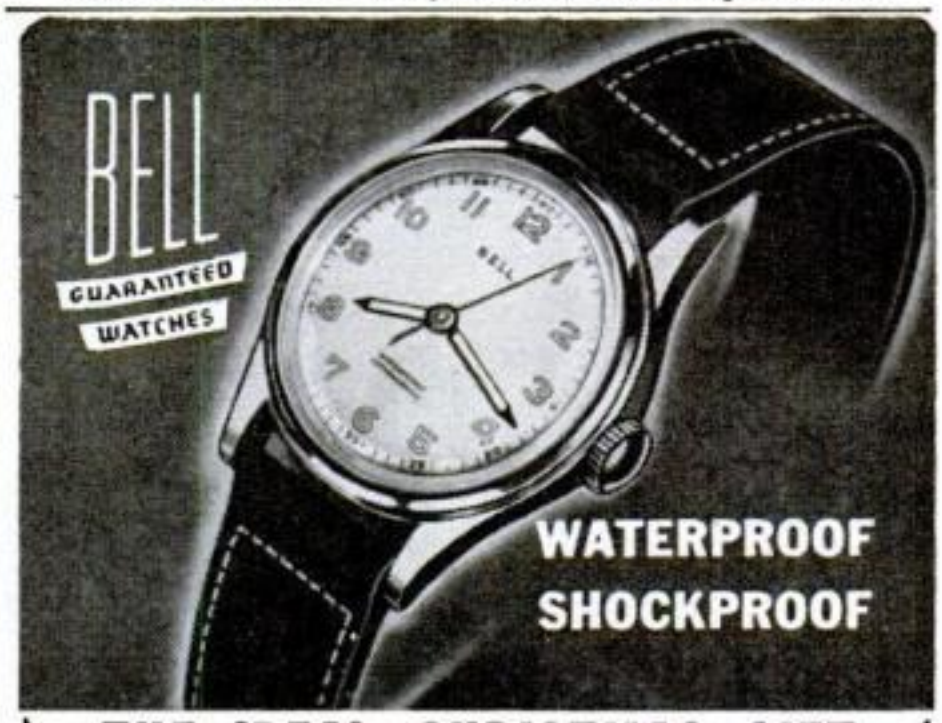


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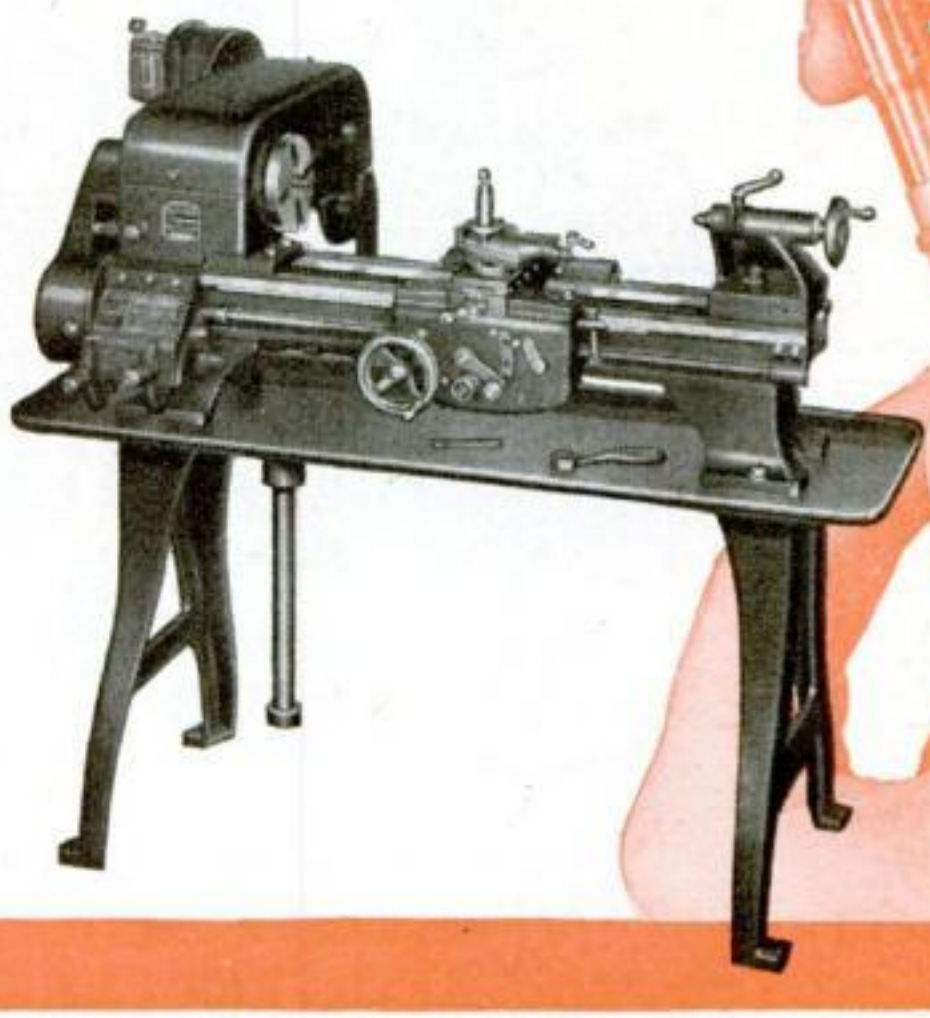
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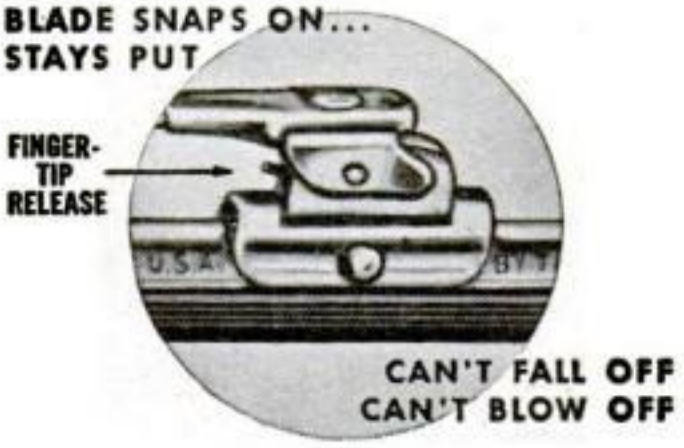
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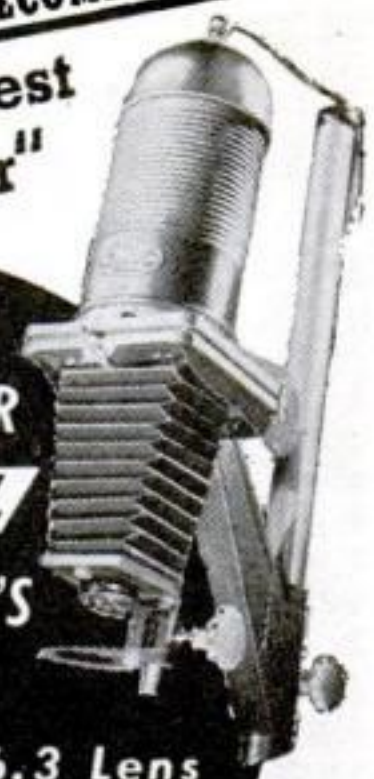
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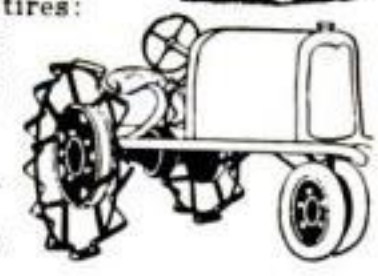
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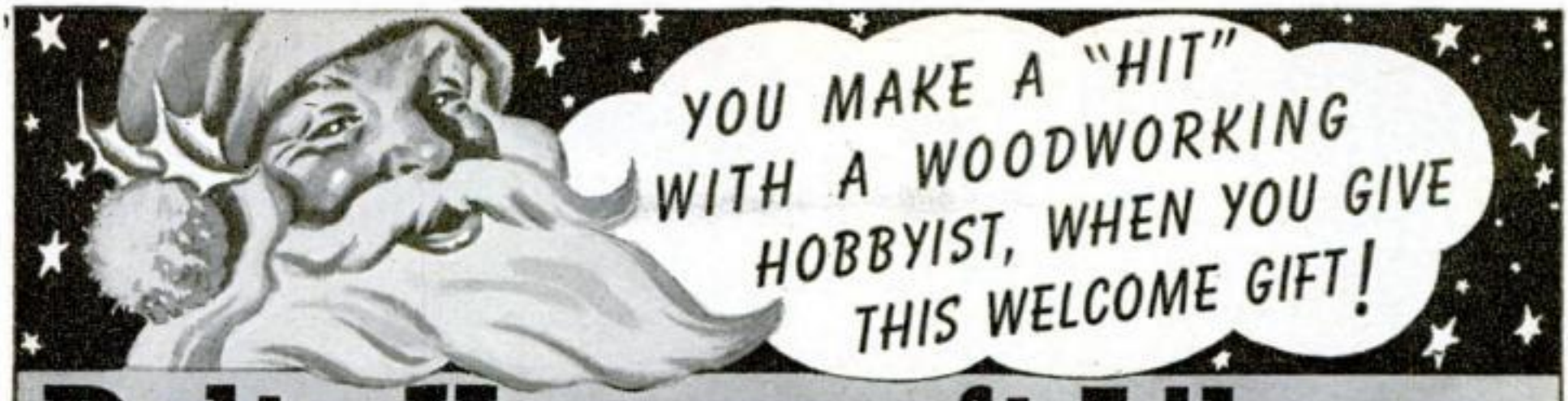


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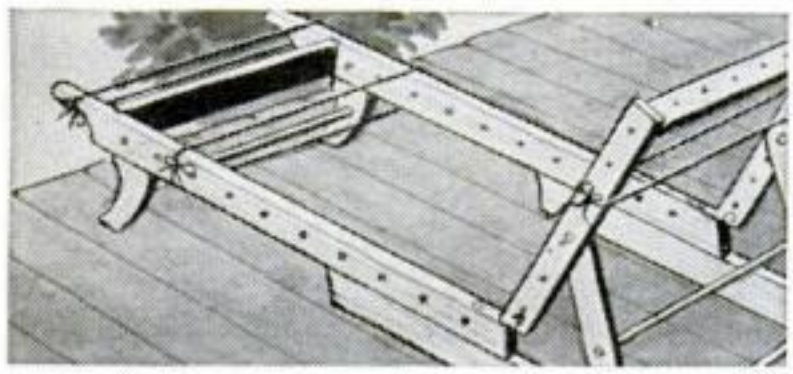
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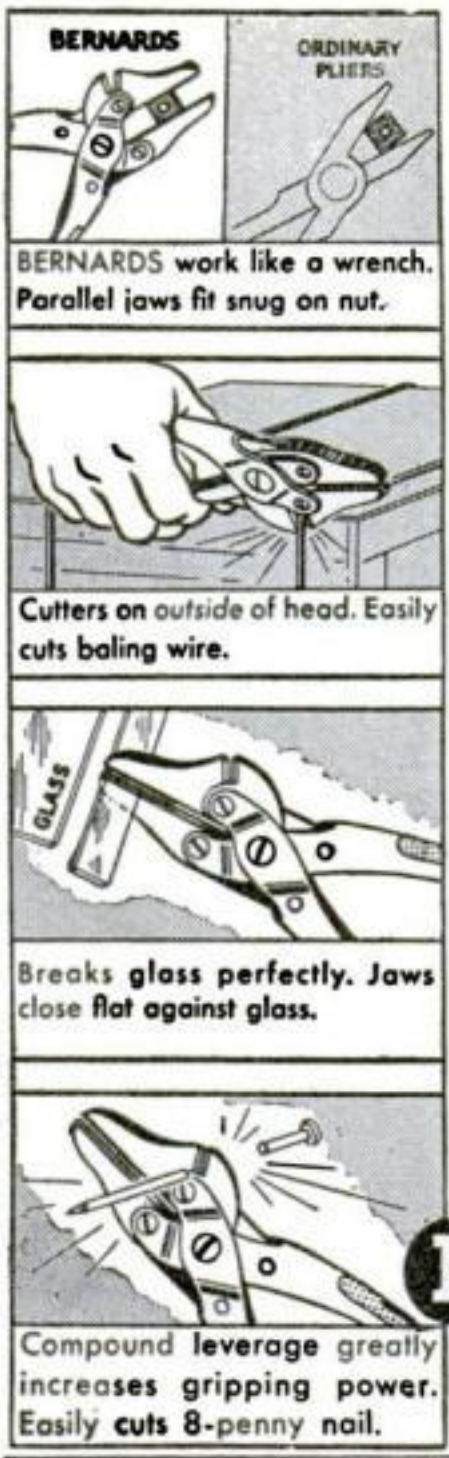
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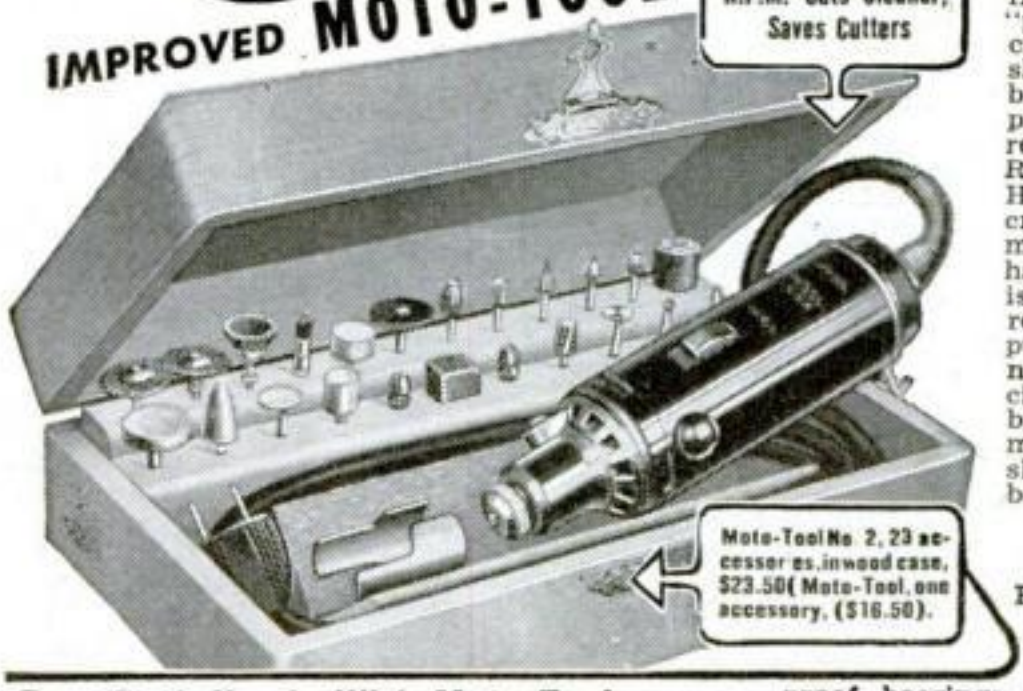
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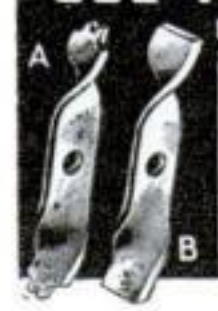
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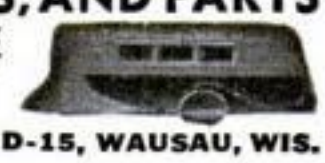


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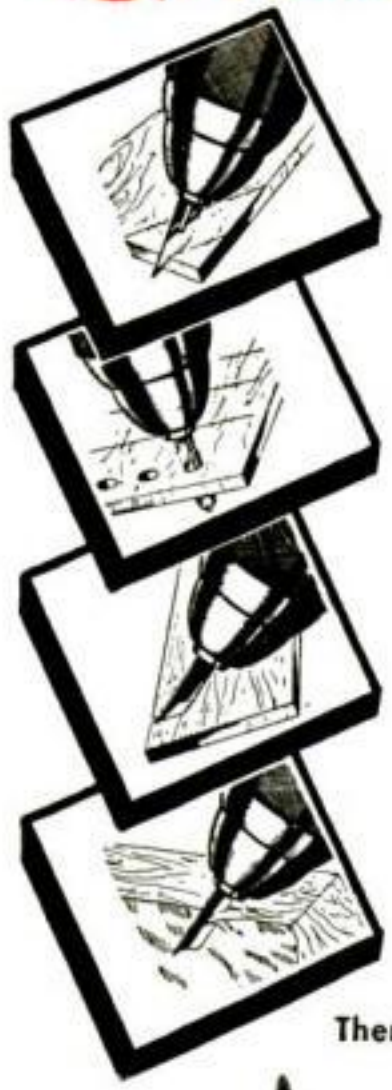
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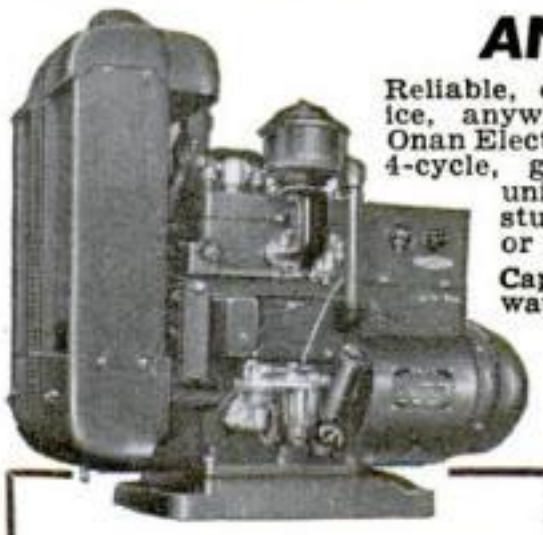
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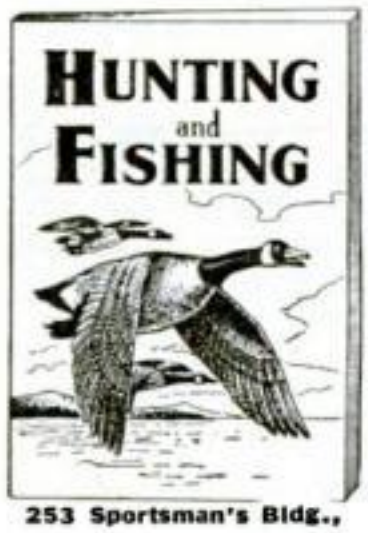
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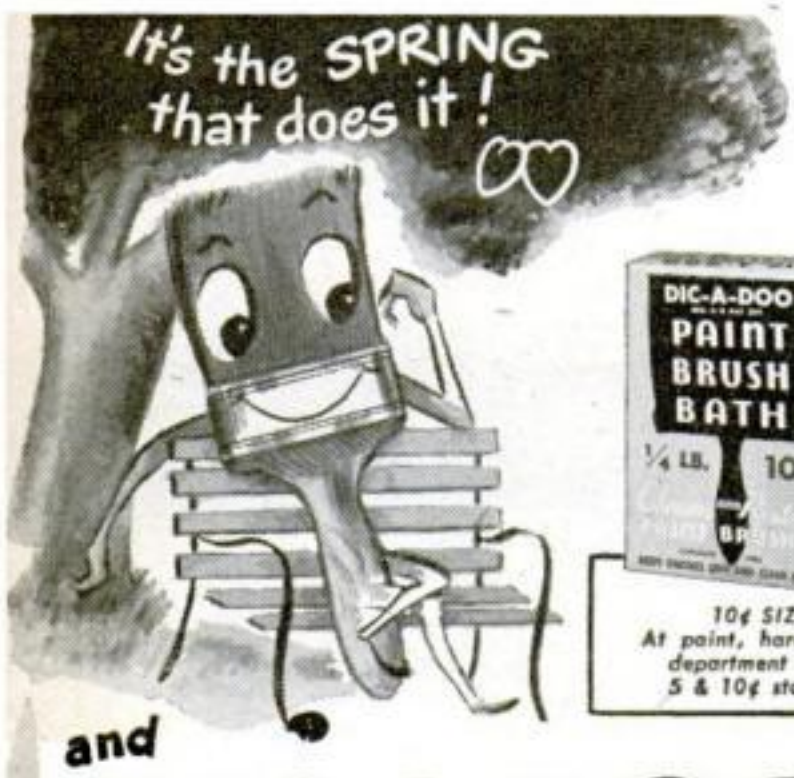
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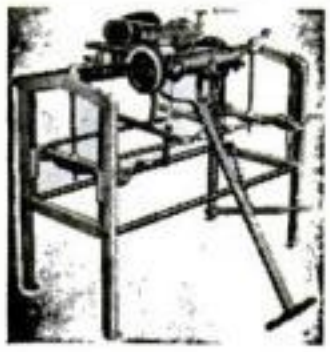
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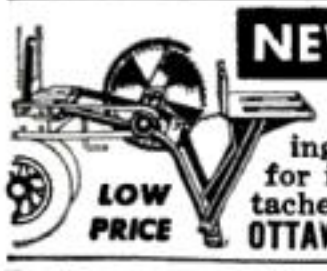
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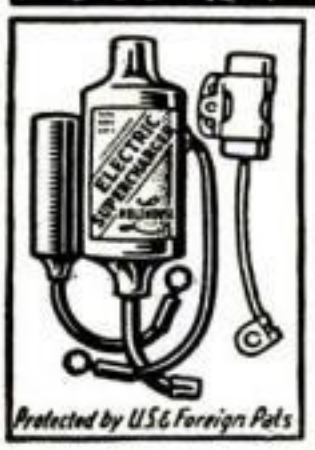
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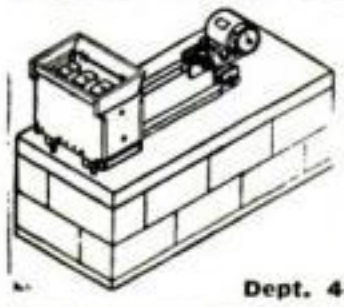
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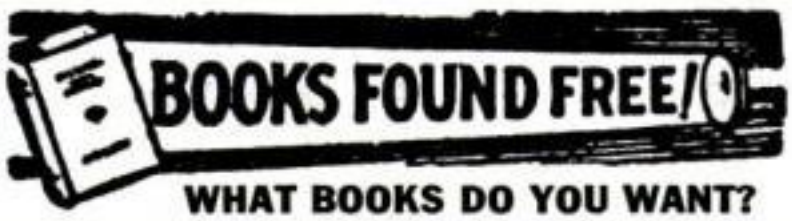
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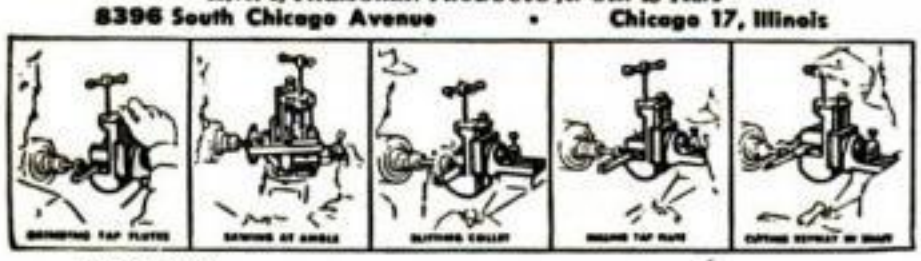
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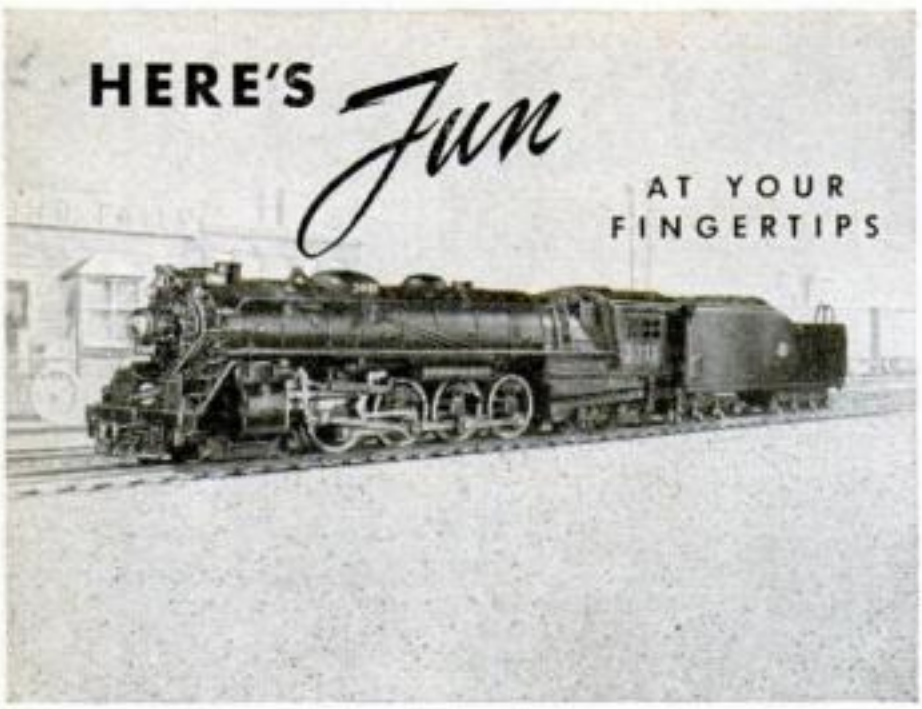
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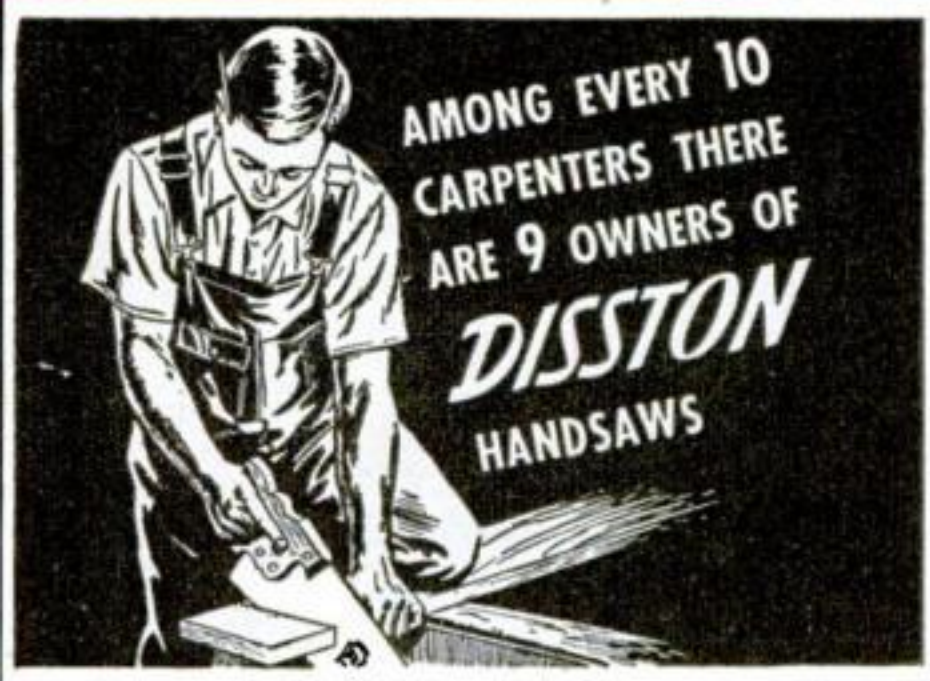
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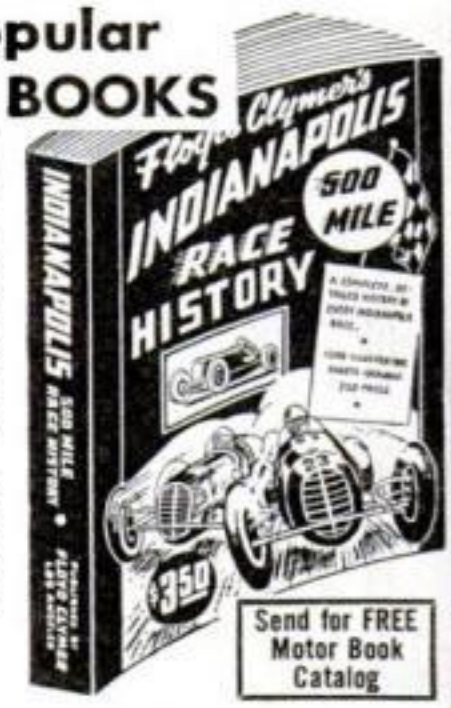
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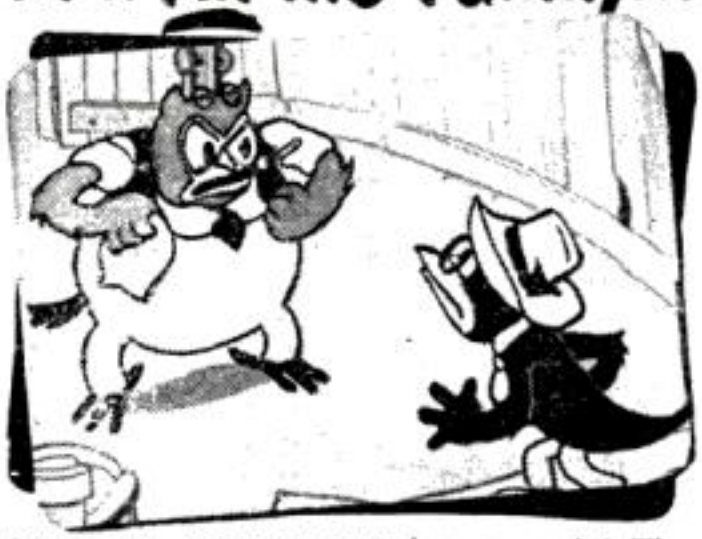
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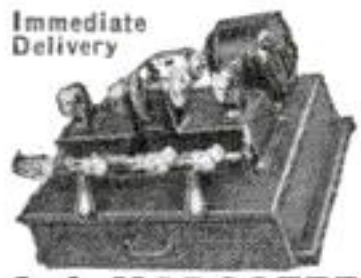
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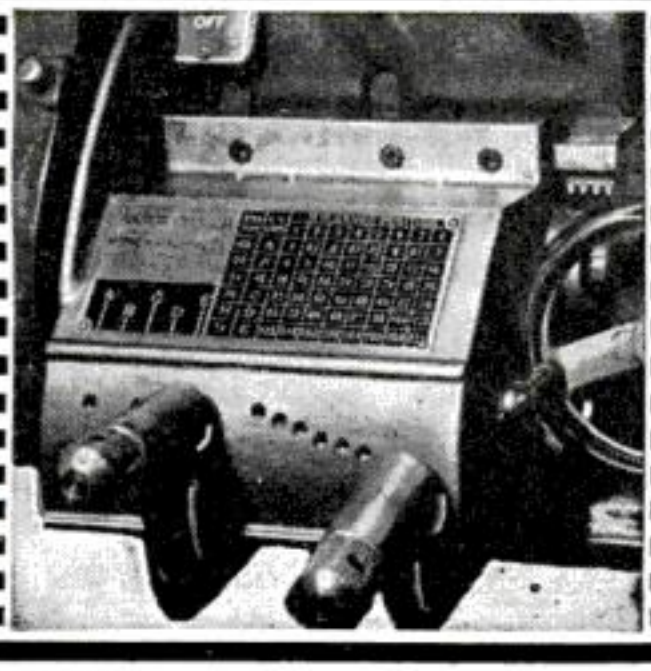
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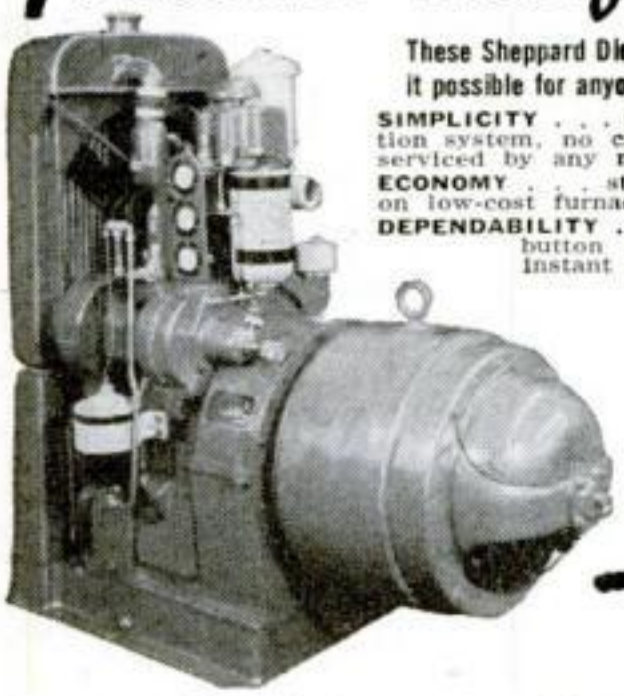
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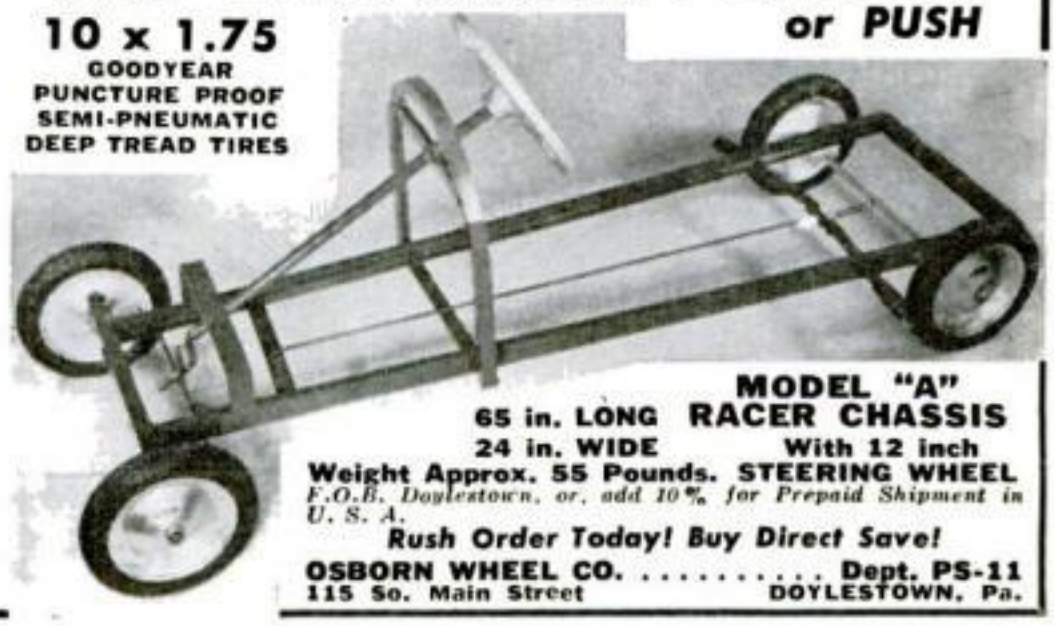
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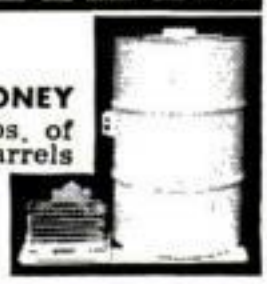
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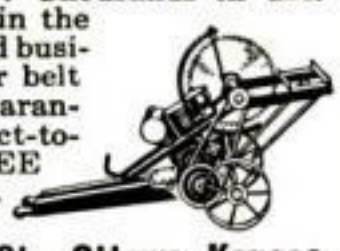
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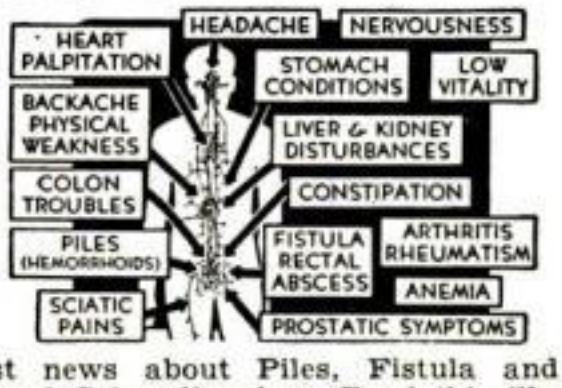




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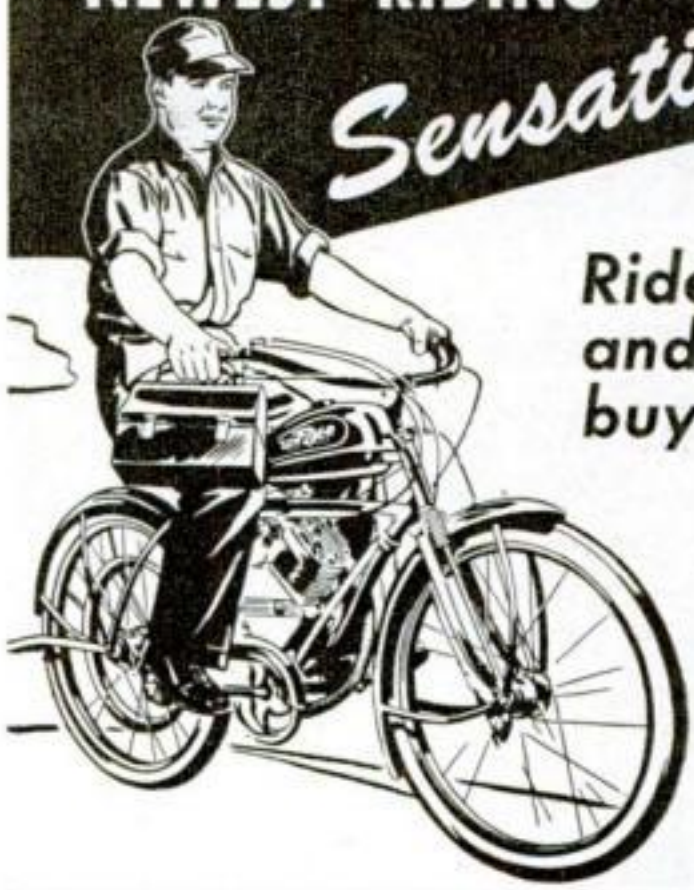
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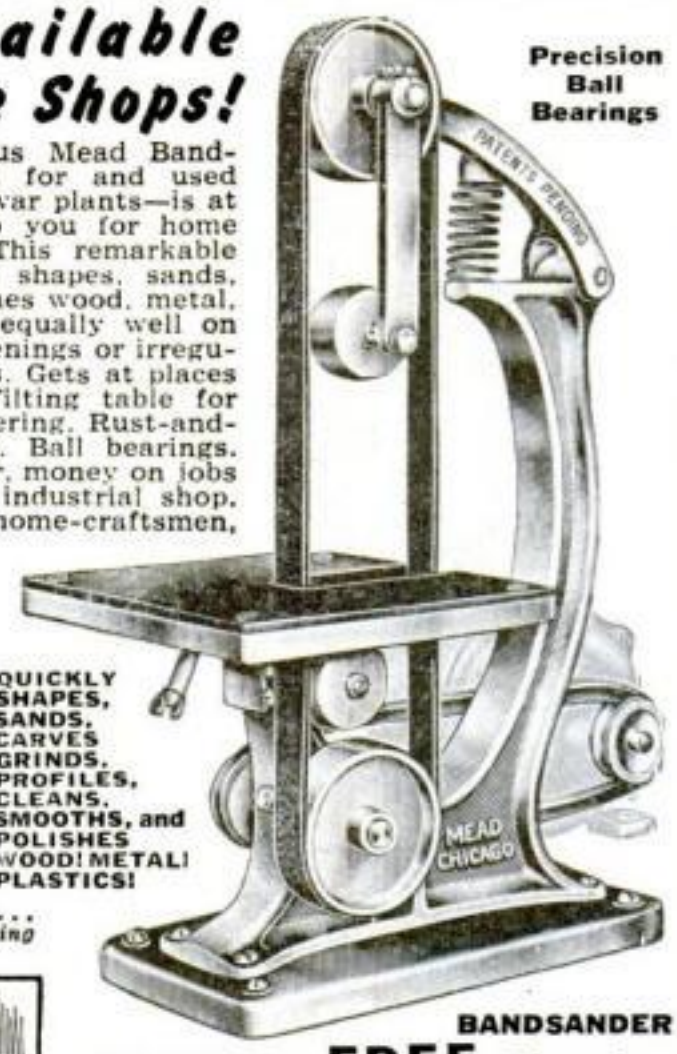
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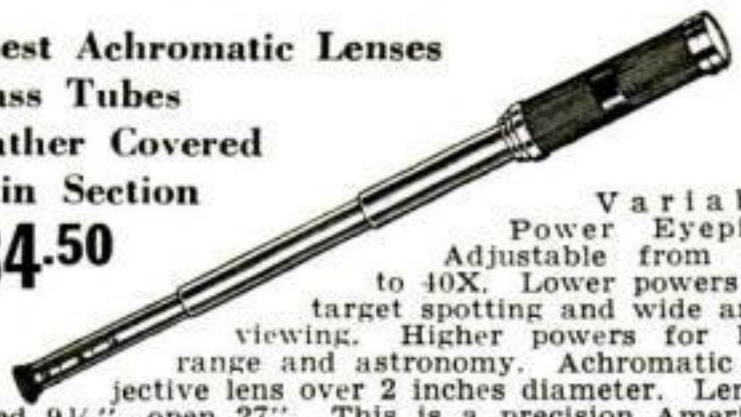
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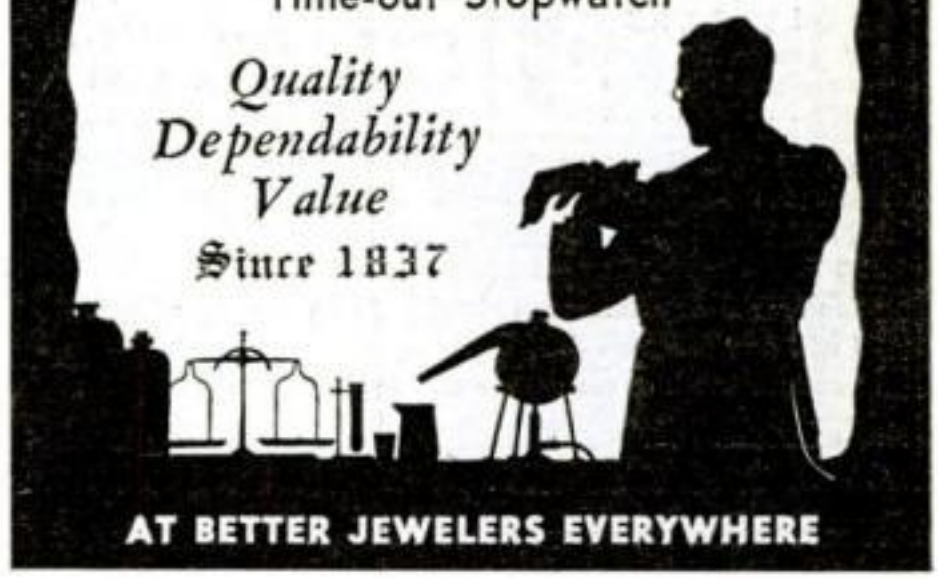
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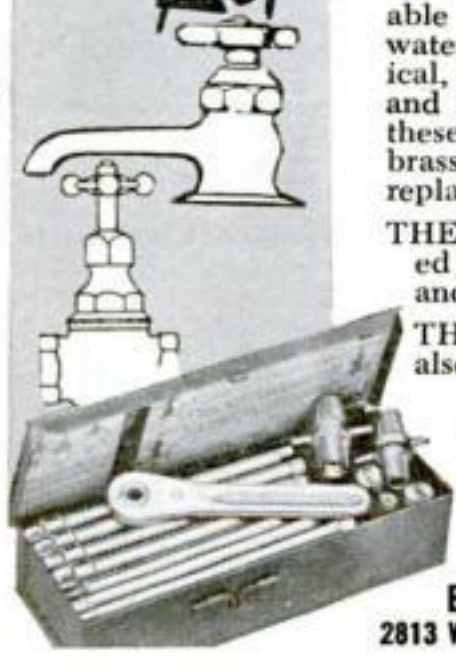
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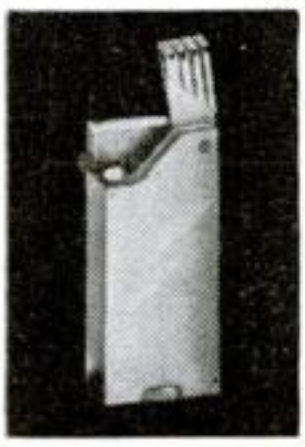
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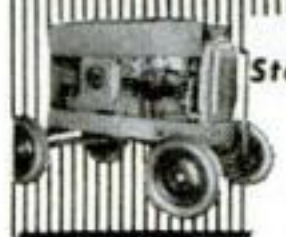
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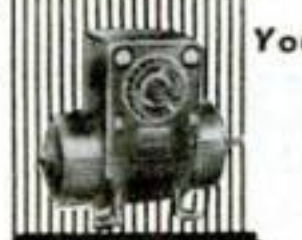
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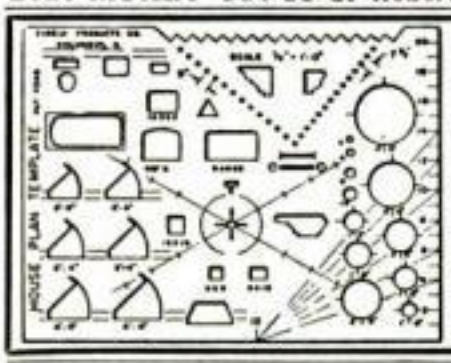
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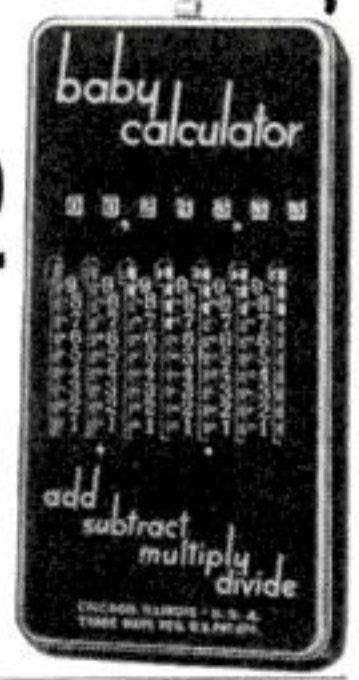
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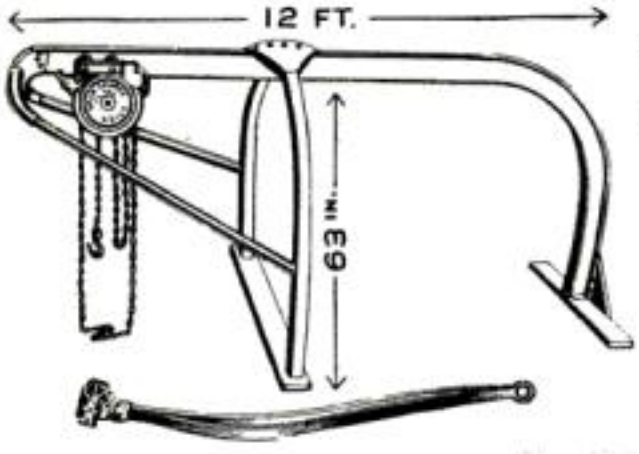
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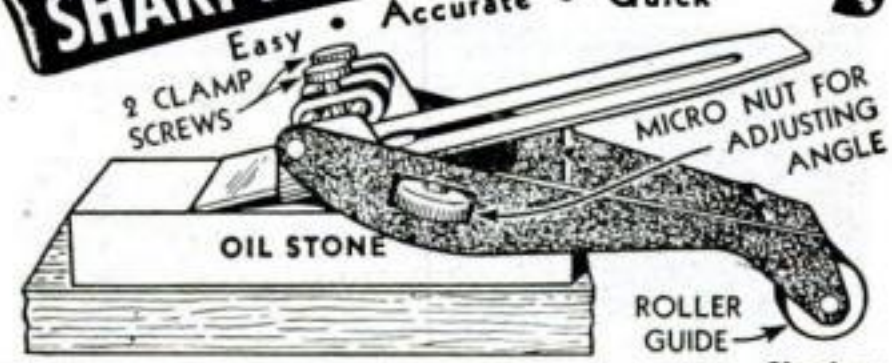
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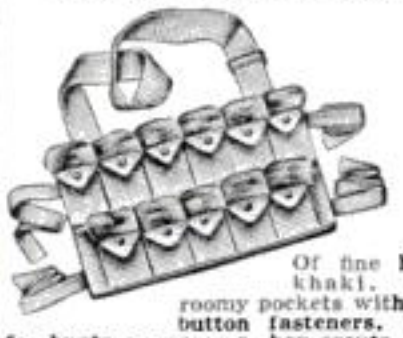
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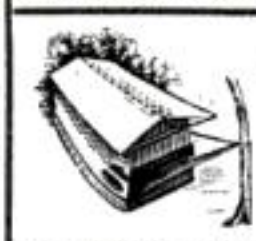
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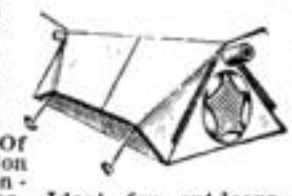
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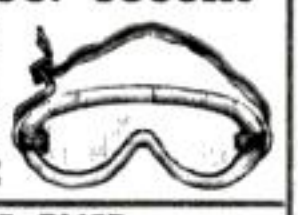
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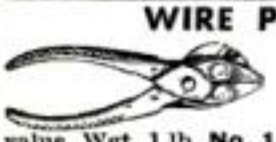
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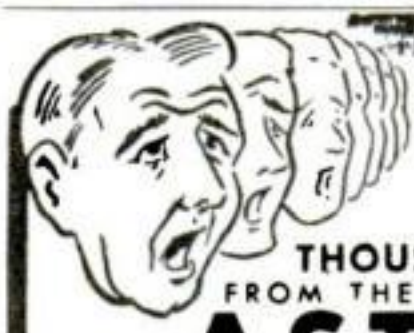
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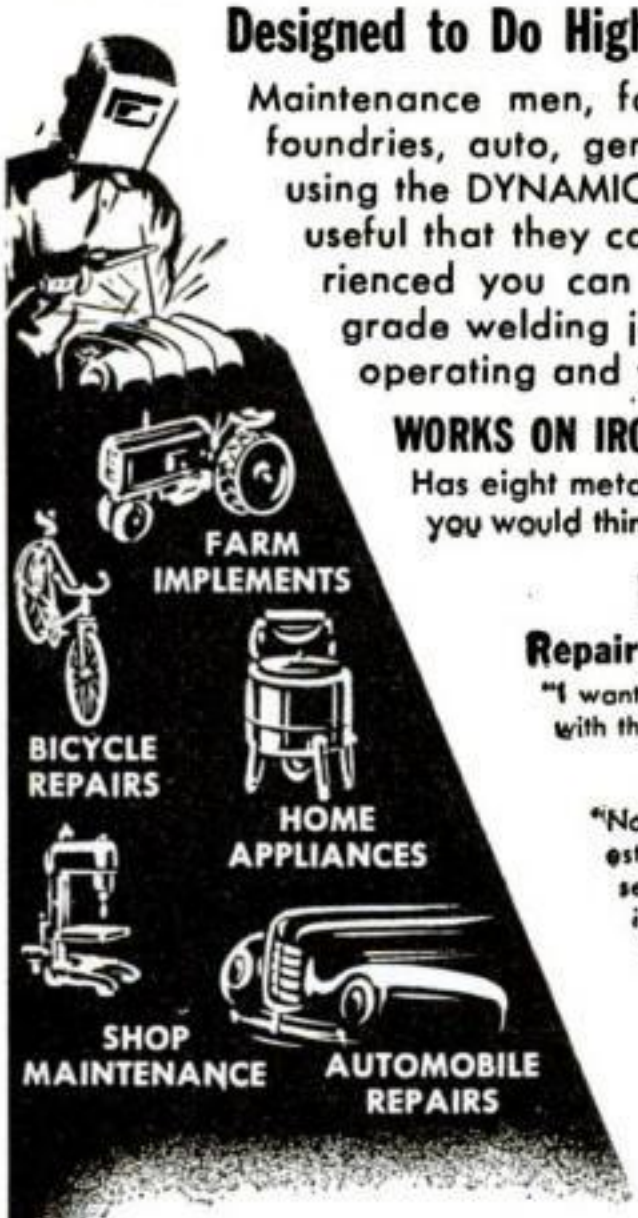
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TO: Reader
FROM: Editor

"Where do you get all that material?"

IT HAPPENS to all of us on the editorial side here at *Popular Science Monthly*. We meet someone on a train, in a shop, at a commercial cocktail party introducing some new gimmick. He says, "Oh, yes, you're with *Popular Science*. . . ." Then he pauses delicately.

"Tell me," he says, "where do you people get all that material?"

Actually, it's a pretty simple process to describe, if not always so simple to perform:



Howard W. Blakeslee, who wrote "Building Blocks of Science" (p. 104), has been science editor of *The Associated Press* since 1928. An expert in translating the jargon of the laboratories into layman's language, his work has brought him high honors in his field, including a shared Pulitzer Prize, the National Headliners' award and the Westinghouse Medal for distinguished science writing.

we go looking for it. Because we know fairly well the kind of things which interest you, we know what to look for and where to look.

This organized looking begins with an editorial organization not unlike that of a metropolitan newspaper. PSM's reporter-editors keep a watchful eye on the various fields of interest. In every field, there are definite sources of news.

Some of these sources, like the big industrial companies, keep us informed of developments. Some are inclined to be coy and secretive, but a good reporter has a nose in the trade winds; and it is always astounding how much the trade, including the competition, knows of new ideas.

Behind PSM's reporters are their "contacts"—the countless friends in the know who pass on a tip. Beyond PSM's staff are the contributors: the trained observers who may be college professors, master mechanics, newspapermen in other cities, or professional



William P. Vogel, Jr., who wrote "Science's Bob Feller" (p. 92), had a comprehensive background in newspaper and magazine work before he became a free-lance writer. He worked for the *New York Herald Tribune*, *PM*, and *Fortune*, among others, and in 1939-1940 he was a Nieman Fellow at Harvard. His hobbies reflect his interest in science: tinkering with sound systems, studying physics and electronics.

writers who know what we are looking for. These people are constantly suggesting stories. We, at our end, are constantly assigning stories to contributors who have proved their abilities in special directions. Here are three of the men who contributed major stories to this issue, for example.

All of these stories are written especially for *Popular Science Monthly*. And all of them were carefully blueprinted before they



George H. Waltz, Jr., who wrote "Electric 'Slingshot' Launches Planes" (p. 81), has been a writer and editor for 17 years, 13 of them with Popular Science. He got his first job with PSM because the magazine wanted an engineer, which he was, and he wanted to write, which he's been doing ever since. As an AAF officer, he flew 250,000 miles gathering material for air manuals.

were written to fit PSM's purpose as well as its space. This made-to-measure writing and editing is true of all the hundreds of stories, pictures and captions which go into PSM's minimum of 148 editorial pages in each issue.

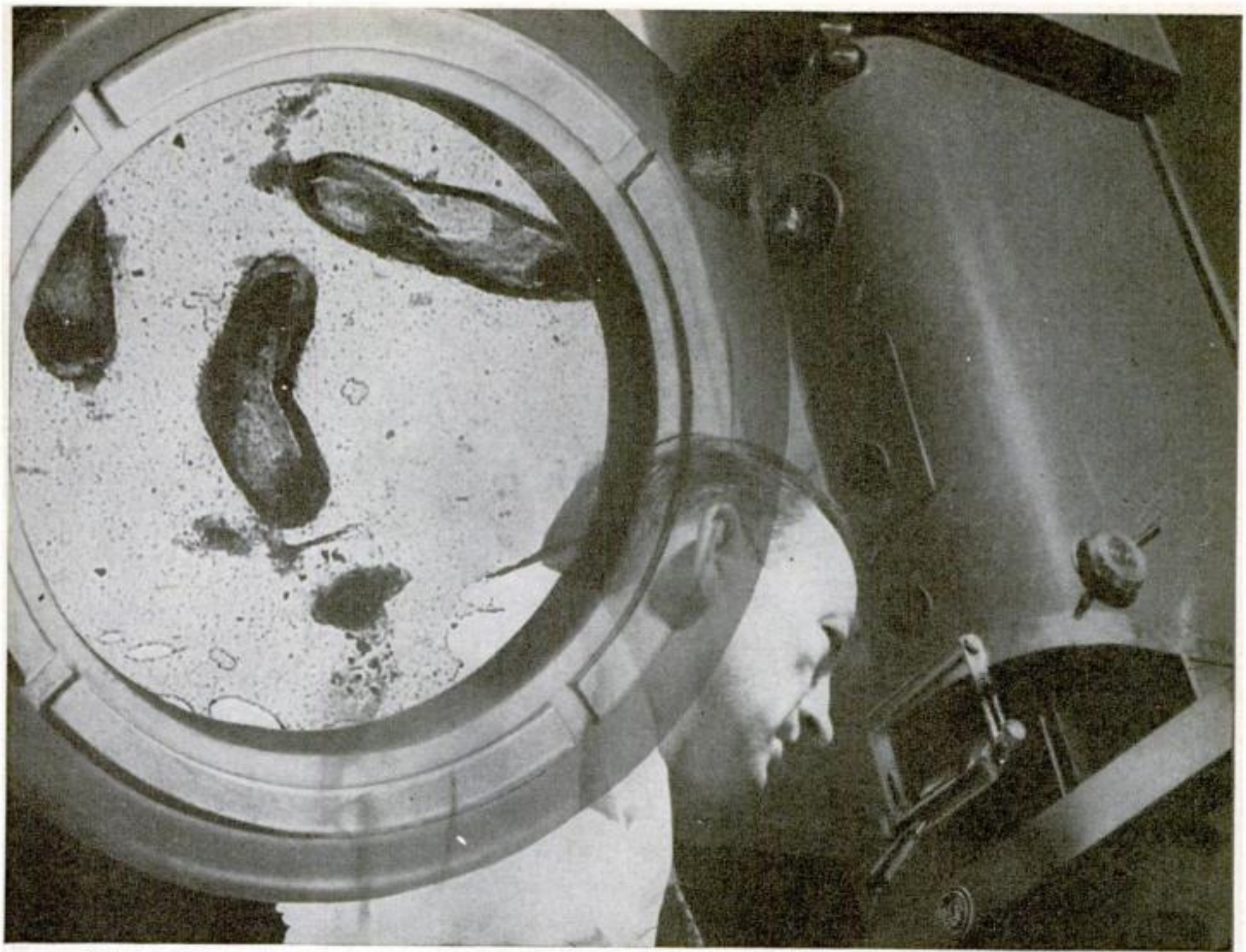
Where do we get all the stuff? Every month, when the advance copy of the forthcoming issue thumps down on my desk and I look it over for the first time, as a reader, I wonder myself!



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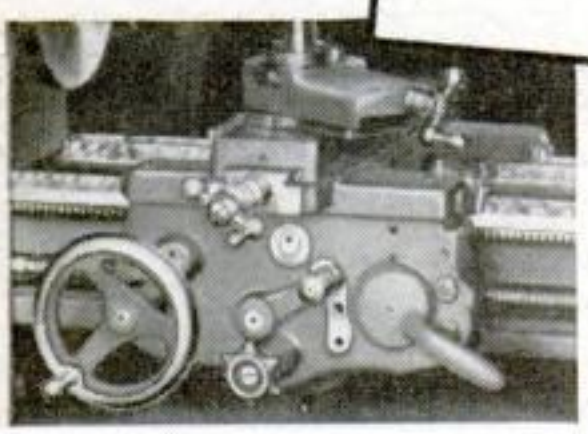
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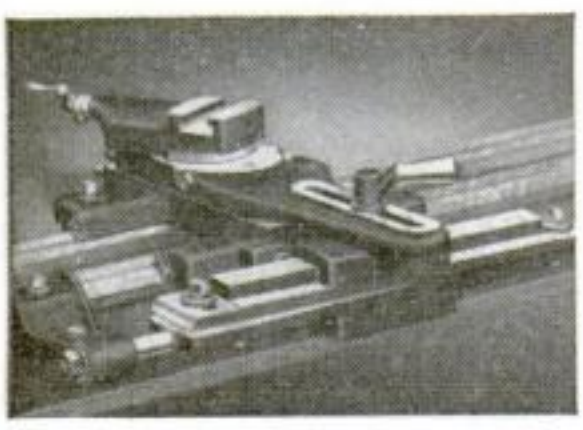


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